ROADS AND STREETS

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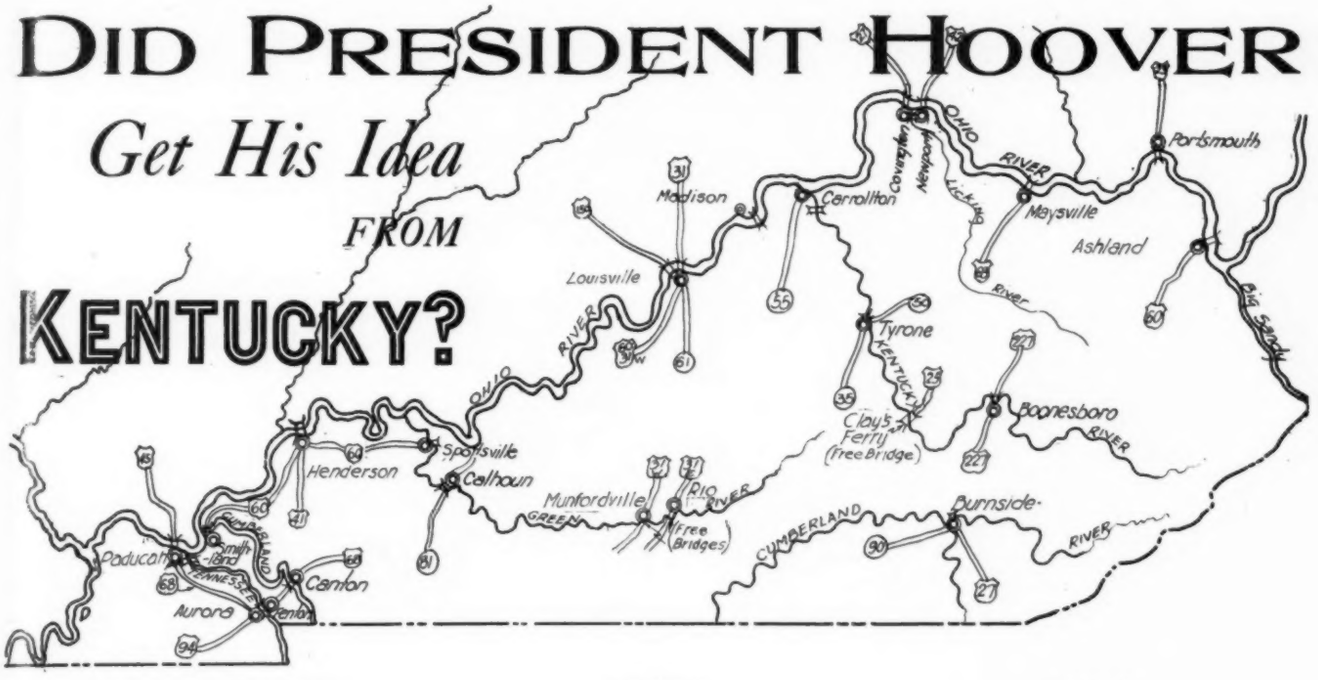
DID PRESIDENT HOOVER *Get His Idea* FROM KENTUCKY?



State-Owned Toll Bridges
Paducah
Burnside
Boonesboro
Tyrone
Spottsville
Eggners Ferry
Canton

Smithland
Maysville
Ashland
Henderson
Municipally-Owned Toll Bridges
Louisville
Privately-Owned Toll Bridges
Calhoun

Paducah
Covington
Newport
Carrollton
Portsmouth
K. & I. Bridge at Louisville
Madison, Ind.
Between Covington and Newport over Licking River

From the earliest days of travel through all the years down to the present, the rivers which border and cross the State of Kentucky, while being a blessing in many respects, have been a great hindrance to the flow of traffic into and across the state.

KENTUCKY is bordered by the Mississippi and the Ohio Rivers on the west, the Ohio on the north, and the Big Sandy on the northeast. The state line between Kentucky and its neighboring state, Illinois, Indiana and Ohio is the low water mark on the north side of the Ohio River and thus Kentucky has within its borders more miles of navigable streams than any other state in the Union. The Tennessee, Cumberland, Tradewater, Green, Barren, Kentucky and Licking rivers thread their way through many hundreds of miles across the state and form barriers at highway crossings that can be spanned by bridges only with considerable expense.

The highway construction program a few years ago had already progressed to the point where these rivers could be reached on almost any main highway route by the traveler on a modern highway. But the highway traffic, which had increased so enormously throughout the last few years, must still thread its way across the river on a ferry which at best was slow and dangerous.

One form of the "self-liquidating" public works proposed by President Hoover for unemployment relief schemes in order to use funds borrowed from the Reconstruction Finance Corporation was that of toll bridges. This article contains a discussion of toll bridge construction of the type desired by the President. It is particularly timely in that it shows how one state satisfied traffic demands from their limited funds.

Very few of the ferries operated on a 24-hour schedule and many of them were tied up for the night after 8:00 or 9:00 P. M.

The loss of life due to accidents at ferries was in itself a very serious matter and the Kentucky Highway Commission a few years ago issued, and has since enforced, very strict regulations regarding ferry operations.

With the very rapid increase in highway traffic that has developed along with the improvement of our highways, these ferries slow, dangerous and uncertain as they were, became big money makers. Naturally the profits made by ferries soon attracted capital to the proposition of erecting bridges at these paying ferry crossings and the Kentucky Highway Commission began to be swamped with applications for permits to build privately owned toll bridges. The commission was opposed to any such plans for the building of these bridges because of the fact that the public was sure to pay heavy toll for a long time if the bridges were built with private capital, and the freeing of the bridges from the toll was bound to be a rather indefinite matter. At best under such a plan the public was sure to pay much more than it should for the construction of the bridges. However, the commission had no revenue with which to construct the bridges for the public.

This was the situation confronting the Kentucky legislature when it met in January, 1928. Out of the legislature came the now famous law known as the Murphy Toll Bridge Act which delegated to the Kentucky Highway Commission authority to issue bonds with which to construct the necessary toll bridges in Kentucky, to operate them as toll bridges until the bonds were retired, and then to declare them free to the public.

The commission lost no time in exercising its power and began at once to have traffic surveys made at all the more important proposed bridge sites. Preliminary work of every kind necessary to the actual construction of the bridges was put under way as rapidly as possible and all necessary steps were taken to clear up all legal issues regarding the legislative act and the sale of bonds. On November 1, 1928, the commission completed arrangements for the purchase of two toll bridges over Green River at Munfordsville and Rio on U. S. 31-W and U. S. 31-E respectively. These bridges had been privately owned and operated for many years, yielding enormous profits to their owners. On November 26, 1930, the bridges had paid for themselves and for a complete reconditioning of each bridge which put them in good condition. The purchase price of the Munfordsville bridge was $225,942.08 and the Rio bridge $64,129.53. Two years of operation as a toll bridge paid this cost and cost of repairs mentioned and they were declared free to the public. Another toll bridge over Kentucky River at Clay's Ferry on U. S. 25 between Lexington and Richmond was purchased by the commission on April 1, 1929, and operated as a toll bridge only 21 months when it, too, had paid for itself and was declared free to the public. This bridge had been operated for many years as a privately owned toll bridge located on one of the most important north and south highway routes in the state. A large portion of the enormous tourist traffic to and from Florida crosses this bridge and it had yielded to its owners vast profits ever since the day when horse drawn vehicles began to disappear from the highways and be replaced by automobiles. An idea of the traffic now using this bridge free of charge may be gotten from the fact that it was only necessary to operate it 21 months as a toll bridge to repay its cost of $205,000.00 at moderate rates of toll.

In spite of all its efforts the commission encountered considerable difficulty in clearing up all legal angles of its bridge program and it was September 10, 1930, that bids were received on the first construction projects to be undertaken by the commission. On that date bids were received for the construction of the Ohio River bridge at Ashland, the Cumberland River bridge at Burnside, and the Green River bridge at Spottsville. Other lettings followed rapidly. On September 15, 1930, bids were opened for the construction of the Ohio River bridge at Maysville, the Tennessee River bridge at Paducah, the Cumberland River bridge at Smithland, and the Kentucky River bridge at Boonesboro. A glance at a map will show the location of these various bridges, the important roads crossing them and the importance of their construction will be readily realized. On September 18, 1930, the commission received bids for the construction of the Ohio River bridge at Carrollton, the Kentucky River bridge at Tyrone, the Tennessee River bridge at Eggner's Ferry, and the Cumberland River bridge at Canton.

The opening of bids for all these bridges came at a most opportune time for the tax-payer and those who will pay the tolls to make these bridges free. Steel prices were at a very low level and the bid prices submitted for these bridges were the lowest ever received in the history of bridge building in this state. The advertisements for the construction of these eleven bridges attracted leading bridge contracting firms from all over the land and the contracts were let to thoroughly experienced, responsible contractors in every case. A large saving was effected in the construction of these bridges over the estimated cost due to the low material prices existing at the time they were advertised. The contract for constructing the Carrollton bridge was not let due to the fact that about $2,000,000 of regular road funds would have been required to supplement the maximum amount that could be obtained from the sale of bonds for this particular bridge. The eight-man highway commission split 4 to 4 on the award of this contract and of course it was not awarded. All other contracts were awarded by unanimous agreement of the commission. A total of $1,877,540 was saved in the amounts of the contracts over the estimated cost of the ten bridges as shown by the biennial report of the commission. This report in describing the bridges says:

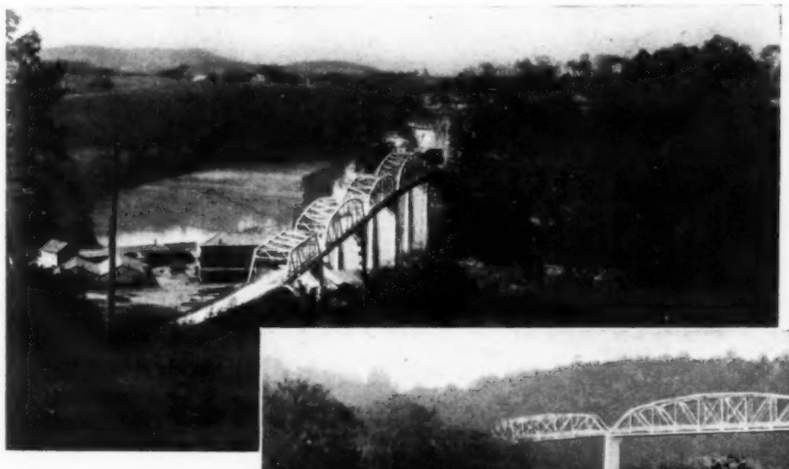
Ashland-Ohio River Bridge.—"The bridge is cantilever type with filled retaining wall, steel viaduct and truss approaches. The main bridge of cantilever type has central span of 739 feet and side spans of 431 feet and 430 feet 8½ inches. The approaches consist of 222 feet of filled approach, 675 feet 6 inches of steel viaduct and truss spans. The total overall length is 2,498 feet plus, including expansion gaps. Roadway width 22 feet and one 5 foot sidewalk. Floor is concrete base, rock asphalt top. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $755,965.00. Contract cost, $579,450.00.

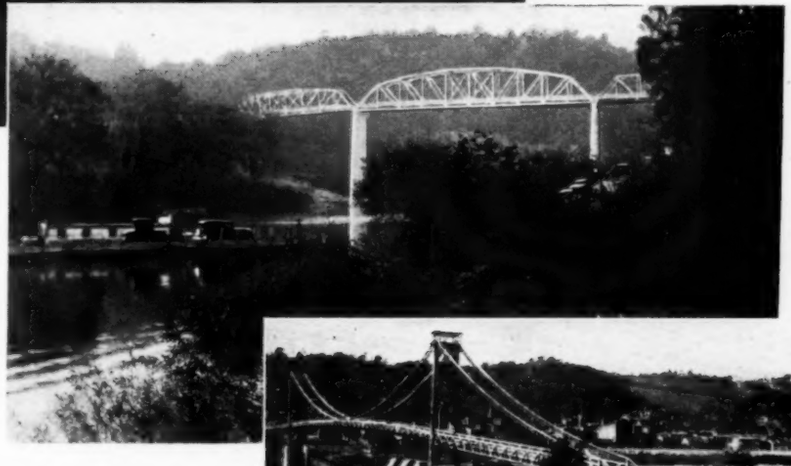
Maysville-Ohio River Bridge.—"The bridge is suspension type with filled retaining wall and steel deck plate girder approaches. The main bridge of suspension type has central span of 1,060 feet and side spans of 465 feet each. The approaches consist of 298 feet of filled approach, 875 feet and 11 inches of deck plate girder spans and anchorage abutments. The total overall length is 3,163 feet plus, including expansion gaps. Roadway width 20 feet and one 4 foot 8 inch sidewalk. Floor is reinforced concrete. Substructure is concrete and river piers are faced with stone. Estimated contract cost, bridge superstructure and substructure, $1,343,000.00. Contract cost, $1,196,809.00.

Henderson - Evansville - Ohio River Bridge. "The bridge is cantilever type with steel plate girder and truss approaches. The main bridge of cantilever type has channel spans of 720 feet and 600 feet and side spans of 540 feet and 432 feet. The approaches consist of 3,013 feet 7 inches of steel plate girder and truss spans. The total overall length is 5,395 feet plus, including expansion gaps. Roadway width is 30 feet. Floor is reinforced concrete. Substructure is of concrete. Estimated contract cost bridge, superstructure and substructure, $2,389,260.00. Contract cost $1,582,995.00.

Burnside-Cumberland River Bridge.—"The bridge is simple truss style and consists of two 126 feet steel truss spans, two 200 foot 3 inch steel truss spans and one 291 foot 6 inch channel span. The total overall length face to face of abutments, including expansion gaps, is 955 feet plus. Roadway width is 24 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost bridge, superstructure and substructure, $249,075.00. Contract cost $190,659.47.

Canton-Cumberland River Bridge.—The bridge is simple truss type with steel viaduct and truss approaches. The main bridge over river channel consists of two 320 foot steel truss spans. The approaches consist of two 120 foot steel deck truss spans and 2,160 feet of steel viaduct made up of 45 foot spans. The total overall length, including expansion gaps, is 3,045 feet. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $465,199.00. Contract cost, $373,160.52.





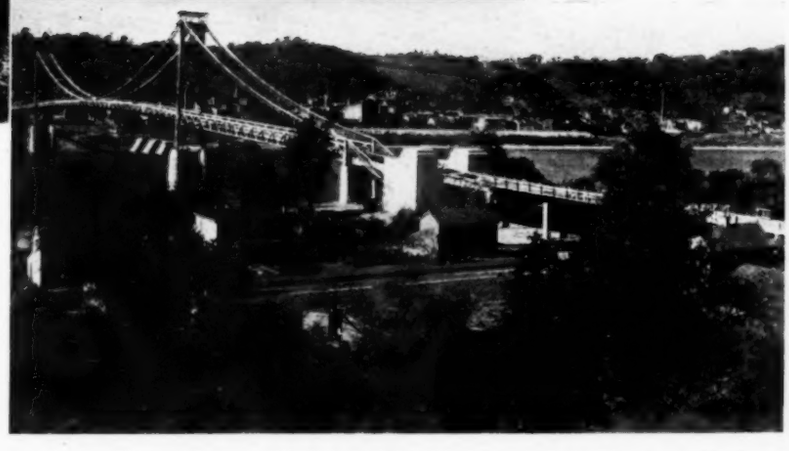
Smithland-Cumberland River Bridge.—The bridge is simple truss type with steel plate girder approaches. The main bridge over river channel is one 500 foot steel truss span. The approaches consist of 1,314 feet of steel plate girder spans. The total overall length of bridge, including expansion gaps, is 1,815 feet plus. Roadway width is 20 feet. Floor is reinforced concrete. The substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $382,045.00. Contract cost, $360,332.00.

Eggner's Ferry-Tennessee River Bridge.—"The bridge is simple truss type with steel viaduct approaches. The main bridge over river channel consists of three 320 foot steel truss spans and one 366 foot steel truss span. The approaches consist of two 150 foot truss spans and 1,710 feet of steel viaduct made up of 45 foot spans. The total overall length, including expansion gaps, is 3,348 feet. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $716,162.00. Contract cost, $535,642.82.

Paducah-Tennessee River Bridge.—"The bridge is simple truss type with steel plate girder approaches. The main bridge over river channel consists of three 400 foot steel truss spans. The approaches consist of 1,825 feet of steel plate girder and beam spans. The total overall length, including expansion gaps, is 3,032 feet plus. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $715,525.00. contract cost, $544,634.00.

Boonesboro-Kentucky River Bridge.—"The bridge is simple truss type with reinforced concrete girder approaches. The main bridge consists of two 140 foot steel truss spans and one 250 foot steel truss channel span. The approaches consist of eight 53 foot concrete deck girder spans. The total overall length, including expansion gaps, is 961 feet plus. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $225,275.00. Contract cost $175,696.74.

Tyrone-Kentucky River Bridge.—"The bridge is simple deck truss type with steel beam span approaches. The main bridge consists of two 224 foot steel deck truss spans and one 360 foot steel deck truss channel span. The approaches consist of 438 feet of steel



At Top—Burnside Bridge Over Cumberland River; Center—Boonesboro Bridge Over Kentucky River, also Showing Old Ferry at This Location; At Bottom—Maysville Bridge Over Ohio River.

KENTUCKY TOLL BRIDGE DATA

Bridge Name	Substructure Contractor	Amount of Contract	Superstructure Contractor	Amount of Contract
Ohio River Bridge at Ashland.....	The Vang Construction Co., Pittsburgh, Pa.	$141,280.00	Mt. Vernon Bridge Construction Co., Mt. Vernon, Ohio	$438,170.00
Cumberland River Bridge at Burnside..	E. R. Mills, Charleston, W. Va.	70,367.32	E. R. Mills, Charleston, W. Va.	118,289.15
Green River Bridge at Spottsville.....	Koss Construction Co., Des Moines, Iowa	67,979.75	International Steel and Iron Co., Evansville, Ind.	118,927.48
Kentucky River Bridge at Boonesboro...	J. A. Kries and Sons, Knoxville, Tenn.	119,360.00	Vincennes Bridge Co., Vincennes, Ind.	56,336.74
Tennessee River Bridge at Paducah.....	Union Bridge and Construction Co., Kansas City, Mo.	237,240.00	International Steel and Iron Co., Evansville, Ind.	307,394.00
Cumberland River Bridge at Smithland.	Dravo Construction Co., Pittsburgh, Pa.	147,470.00	Nashville Bridge Co., Nashville, Tenn.	212,862.00
Ohio River Bridge at Maysville.....	Dravo Construction Co., Pittsburgh, Pa.	460,160.00	John A. Roebling's Sons, Trenton, N. J.	720,600.00
Kentucky River Bridge at Tyrone.....	Henry Bickell Co., Louisville, Ky.	125,401.32	Virginia Bridge and Iron Co., Roanoke, Va.	171,965.72
Tennessee River Bridge at Eggner's Ferry.	Union Bridge and Construction Co., Kansas City, Mo.	237,545.34	Vincennes Bridge Co., Vincennes, Ind.	298,097.48
Cumberland River Bridge at Canton....	Gould Contracting Co., Nashville, Tenn.	142,036.20	Nashville Bridge Co., Nashville, Tenn.	231,124.32

beam spans. The total overall length, including expansion gaps, is 1,254 feet plus. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $410,090.00. Contract cost $297,367.04.

Spottsville-Green River Bridge.—"The bridge is simple truss type with concrete girder and steel deck truss approaches. The main bridge over river channel consists of one 161 foot steel truss span and one 360 foot steel truss span. The approaches consist of four 116 foot steel deck truss spans and two 53 foot concrete girder spans. The total overall length, including expansion gaps, is 1,103 feet plus. Roadway width is 20 feet. Floor is reinforced concrete. Substructure is concrete. Estimated contract cost, bridge superstructure and substructure, $249,595.00. Contract cost, $186,907.23."

Deserving of special mention among these bridges is the Ohio River bridge at Maysville. It is the only suspension bridge in the group and is one of the four long-span bridges of parallel-strand type built since the manufacture of bridge strands of high and uniform modulus of elasticity was perfected about three years ago. Contrary to general opinion concerning the erection of such cables, foot-bridges were used successfully and the cables were erected in nine days. The two towers were erected (not riveted) in the remarkable time of three and one-half and four and one-half days, respectively. Aluminum fillers transformed the hexagonal cable to a 13 inch circle for wrapping.

The first of these bridges to be completed and opened to traffic was the Ohio River bridge at Ashland, which was completed and dedicated in September, 1931, one year after the bids for its construction were opened and contract awarded.

The bridges at Boonesboro, Burnside, Maysville and Smithland were all completed and opened to traffic during November, 1931, just two months more than a year after contracts for their construction were awarded.

December saw the completion of the Spottsville and Paducah bridges and the bridges at Canton and Eggner's Ferry were completed during March, 1932. The Tyrone Bridge was completed and dedicated June 8, 1932.

The Ohio River bridge at Henderson, Kentucky, joining Henderson with Evansville, Indiana, is being constructed by the Kentucky Highway Commission and the Indiana Highway Commission jointly. Contracts were let and supervision of construction of this bridge performed by the Indiana Highway Department. It was completed in June of this year, bringing to a close for the time being the toll bridge construction program of the Kentucky Highway Commission.

The commission has practically completed arrangements for the purchase from the private owners of a toll bridge over the Kentucky River at Carrollton. Traffic on the important Louisville-Cincinnati highway must cross this bridge and it is estimated that tolls collected for two years will repay the cost and make it a free bridge also.

Traffic over those bridges already opened is equal in every case to the estimates of the traffic, upon which the bonds for their construction were sold. The tolls now being collected will be used to retire the bonds as speedily as possible so that these important bridges may be free to the traveling public.

Kentucky and her state highway commission are to be congratulated on the construction of these eleven important bridges that will mean so much to the flow of trade and travel in this state.

Operating expenses and maintenance of the bridges must be paid for out of the regular state road funds so that all tolls go directly to retire bonds and the public in this way has been given the badly needed bridges at economical costs and they will be free bridges just as soon as tolls retire bonds for their cost. Tolls will be collected on the Ohio River bridge at Henderson only long enough to pay the bonds for Kentucky's one-half of the cost of this bridge. The other one-half of the cost of this bridge was paid by the Indiana State Highway Commission.

The entire supervision of the operation of these eleven toll bridges is directly in the hands of the Kentucky Highway Commission and they have authority to build several more toll bridges at important river crossings when traffic conditions and road construction now going rapidly forward warrant the erection of the bridges. The several privately owned toll bridges in Kentucky were built before authority was given the commission to build toll bridges and no permits for the erection of privately owned toll bridges have been issued since the commission has had this authority to build them for the people.

The City of Louisville owns the $5,000,000 toll bridge over the Ohio River at Louisville and it will be free also when tolls now being charged have paid for the operation and cost of construction.

No more progressive step has been taken in recent years in Kentucky than that Act of the 1928 Legislature which made the construction of these bridges possible.

HIGHWAYS

An Analysis of the Mechanics of Highways with Some Thoughts Concerning Economics and Other Considerations Concerning Highways and the Part They Play in the Present Day

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THIS discussion is not intended to be conclusive or thorough. Though the thoughts expressed result from years of active experience in City Planning matters, the subject is here purposely treated from a lay standpoint but with such degree of logic as the writer is capable of employing. It is anticipated that a clear statement of the subject in non-technical terms, if sufficiently convincing, will be later substantiated by technical data supplied by those whose interest in the subject and technical training qualify them to finish the picture.

EDITOR'S NOTE

One should not fail to realize, in reading this article, that while a highway system, ar a plant unit, or a machine may not be efficient it may still be economically justifiable. Lack of efficiency does not necessarily infer lack of economic justification.

The words inserted in brackets are ours.

The evolution of the highway has been very gradual until very recent times. Since a time some two decades ago, the changes have been very rapid. This later period has been fixed by the advent of the motor vehicle. As the efficiency of the automobile was improved, it naturally came into more general use until at the present, its employment in this country has become so general as to practically exclude all others forms of ground movement not employing rails.

With the rapid increase in safe and reliable speed, and the development of ever-increasing load capacities, the motor vehicle has compelled rapid changes in the physical characteristics of highways that they might make possible an ever-increasing utilization of the utility that is biult into the modern vehicle.

These changes in design and construction of highways, however, though fundamental in a theoretical way, do not make provision for certain fundamental considerations that very definitely measure the degree to which this inherent utility of the automobile would make possible.

Most of the changes to date have involved matters of grade, curvature, super elevation and such factors as daylighting and types of sub grade and surfacing. In these matters, there have been great advances. In a limited sense, they may be said to apply recognized laws of physics to the problem.

The motor vehicle has done more, however, than to compel a change in the physical design of the highway. It has brought about automatically a classification of thoroughfares into two broad groups. These may be spoken of as streets and highways.

For purposes of this discussion, streets are still of that type thoroughfare that was typical of all thoroughfares up to the time that the automobile became a serious factor. They consist now, as then, of public reservation created and maintained for the primary purpose of affording convenient and legal access to the properties abutting upon them.

With the advent of the automobile, however, with its greater speed and longer efficient travel radius, certain of the existing streets or roads lent themselves to a new purpose. Because of their location, direction, continuity, grades, curvatures and the importance of their termini, they become singled out by the autoist as best lending themselves to the longer and the faster trips between objective points.

This natural process of selection produced a cumulative effect upon the volume of traffic that such thoroughfares were called upon to accommodate. The inevitable result of this condition was the launching of a movement to increase their capacities by widening and straightening and leveling. Extensions to the system came next and then additions through openings in urban districts and the construction of long ribbons of hard surfaced thoroughfares through rural areas and the *highway,* as it is now known, was born.

The increase in the utilization of the motor vehicle by reason of more adequate travel ways being made available has been staggering. How much the modern highway has induced the improvement in the automobile or how much the improvement of the automobile has brought about a betterment in highways presents a subject that must be left for answer when we decide that other age-old problem of "Which came first, the chicken or the egg?"

The fact remains that we are now confronted with the problem of serious congestion in spite of the vast increase in the mileage of highways and a general improvement in their widths and other physical characteristics. This situation has given rise to a general study of the subject and in isolated cases, interesting experimentation has been resorted to. In the main, however, most of the effort has emphasized greater number of highways but always with the same lack of fundamental change in the general treatment.

As we begin a more thorough analysis of the subject, we first become aware of the fact that the problem presents two distinct phases. These are the financial and the physical. Though the purpose of this discussion is primarily to consider the physical features of the subject, we find that the financial difficulties present certain considerations that cannot be ignored if the main problem is to be adequately treated.

The financing of highways assumes different forms in different parts of the country. The methods employed may be roughly divided into two classifications—general and local assessments.

In the case of general financing, there may be a further distinction between city, county, state or state and federal. Basicly, there is slight difference between these. They are all predicated upon the theory that the modern highway system is an institution of general need and the cost is accordingly met on a general basis. Whether general funds are derived from bond monies, general current taxes or special gasoline taxes, the principle is largely the same. Certain considerations of propriety concerning the economics of those general funds being selected offer much food for thought in determining local policies, but at the same time, this subject is somewhat out of place in the present discussion. For that reason, the subject will be passed over except for this statement of the fact that the problem exists and requires earnest attention at the proper time.

When we consider the subject of assessment for benefits, however, we discover a closer relationship between it and the main topic of this discussion.

The special assesment method of financing public improvements, developed most extensively in the West, dates back a long time. The conditions that prevailed in years past made this practice both logical and necessary. In California especially, the unprecedented growth demanded a high degree of local initiative and independence, and the local assessment method met that need. When the method was first established, however, a condition radically different from the present existed, especially with respect to roads. The automobile was not yet a factor. Streets, or roads, in those days all rendered a similar service. Their utility was confined to through travel of a very limited radius and for the most part, they served the principal purpose of affording access to abutting properties. Widths, type of improvements and other characteristics were largely a matter of local taste and choice. There was but slight community-wide concern over the treatment of any particular street or road.

Under those circumstances, local financing by special benefit assessments was both logical and proper. The benefit, whether resulting from utility or appearance, or both, was largely a matter of local application. Whether a neighborhood desired minimum facilities to meet its needs or demanded more pretentious treatment in the form of broad parked boulevards was largely a matter of local tastes, initiative, and financing, just as today a person, in order to travel, may employ an inexpensive, small, open car or a luxurious and expensive limousine.

But then came the automobile and with it the natural distinction between local streets and roads as such, and the new type of thoroughfare which we now call highways. The form of roadway utilization that brought the requirement of highways into existence also demanded certain definite characteristics of the highways that distinguished them from purely local streets. Among these qualities was greater width, less grades, greater straightness and more substantial construction. All of these qualities added materially to the cost.

This fact soon began to develop serious difficulties where the special assessment form of financing was employed. The practice, of course, was predicated upon the theory of assessments for benefits and in proportion to benefits. So long as improvements were strictly of a local character and of moderate cost, everything went well. But into this tranquil condition came the new type of more expensive highway. It was at first assumed that the normal increase in traffic upon these new major routes of travel would produce a commensurate benefit upon the abutting frontages. On that assumption, the frontage assessment was employed as a means of financing those new highways. Then difficulties began to manifest themselves. With the passage of time, natural economic adjustments began to occur. It was soon observed, however, that when these readjustments of values (benefits) happened, in many cases the increases did not equal the charges that had been made.

In some cases where extreme topography was involved, it required radical practices in construction, often necessitating large cuts and fills. In many such instances, the abutting properties became actually damaged instead of benefited. In some extreme cases, abutting properties have been effectively isolated from the new and presumed valuable frontage and though technically abutting upon the highway frontage, they are practically completely isolated by their elevation above grade or their depression below it.

Suffice it to say, that so serious has this situation become that where the practice has been generally employed, it has resulted in a virtual revolution against the process but, as is so often the case in revolutions, they are apt to be blind protests against a condition but with no particular objective, or if there be an objective, it probably takes the form of an uncontrolled swing of the pendulum that takes it to the other extreme.

The bearing that this situation has upon our subject of "Highways" now becomes more evident as we observe more closely the tangible results of both methods of financing. The results referred to contemplate the relationship between the modern highway and the property abutting. Whether new highways have been brought into existence by financing at large or by special assessments makes no difference in the relationship of those highways to the areas traversed and more particularly the properties immediately abutting. It happens merely that in the case of special frontage assessments, the discrepancy between cost and benefit is borne home to the minds of the victims in a way that has compelled them to think and because through them, the public generally has been forced to think, and by public, we mean officials and leaders in public policy as well.

Having now been compelled to think, we observe a curious situation. We discover that properties immediately related to highways, if not damaged, are at least not benefited in the main. The tremendous mileage of frontage on any modern highway (street) network is so far in excess of any ultimate economic demand for normal commercial uses that it becomes a drug on the market. By the very nature of the economics involved, insofar as their frontages depend on being utilized for normal business purposes, they are foredoomed to perpetual disuse.

Except for negligible industrial uses, there remain only one possible demand for such frontages—residential. Whatever the form of residential use, these highway frontages are poorly adapted to accommodate. Noise, dirt, fumes, and physical dangers prejudice such frontages for residential purposes when compared to almost any other property in a community. The only conclusion open to us, therefore, is that highway frontages, taken as a whole, must ultimately become the least desirable and therefore least valuable property in any area.

There are, of course, the proverbial exceptions to this rule. They are found in certain strategically located places. Places constituting important termini, or impor-

tant junctions and other property conveniently located with respect to substantial buying power may react in some degree to commercial development. There is also the proverbial man with a better mouse trap to whose door people will wear paths no matter where he locates his business. But we are here dealing broadly in ratios and general community land economics and from that standpoint, the assertions just made are incontrovertible —highway (street) frontages in the main are a real economic problem.

Where, for reasons that need not here be fully analyzed, we find commercial development adjacent to highway (street) frontage, we also find a most peculiar phenomenon that forms the connecting link between the economic and the physical phases of our subject. This phenomenon is the spectacle of the commercial center destroying the effectiveness of the highway facilities that directly or indirectly brought it into existence.

Having passed hurriedly through certain salient economic considerations affecting our subject, we come logically to a more interesting consideration of the physical problem, though it will be necessary as we proceed occasionally to revert to the subject of economics, as the two are inseparable.

There is no necessity of arguing that our highways, individually and as systems, are still far from being perfect. We make ample concessions to our pride when we admit that they are far better than they used to be. They may be better, but they are certainly not perfect, and we are here inquiring into where they lack perfection and in what respects they may be improved, bearing in mind always the element of cost. By cost, we mean not only the monetary cost of construction and maintenance, but the cost in community time, efficiency, and safety.

Reference has already been made to the increasing cost of modern highway (street) construction as compared to the cost of streets when all streets served the same purpose. In urban areas, we now discover that the aggregate cost of a network of highways (streets) is attributable not only to the unit cost, but also to the increasing number of units that are being constantly required. It therefore seems a logical question to ask ourselves—whether or not the unit we already possess are rendering us a dollar's worth of service per dollar expended. The answer is NO!

For so expensive a necessity as our modern highways represent, we will do well to inquire into their efficiency and then to do that which study and experiment indicates as lending to an ever-increasing degree of efficient service per dollar expended. As this question of efficiency is relative, it is essential that we shall first ascertain our present standard and then attempt to better it.

The writer has taken occasion to study the subject, admittedly in somewhat a superficial degree, and yet with sufficient thoroughness to hazard certain demonstrable assertions. The first assertion is that in urban areas, and somewhat in proportion to the demands made upon our major streets, or highways, their efficiency represents but 30 per cent to 40 per cent of the theoretical maximum. In terms of service, therefore, our highways (streets) are really costing us from two and one-half to three times as much as we have generally assumed. In the interest of economy, therefore, it behooves us to increase the efficiency of our highways (streets) and from the standpoint of sound economics, we could afford to pay at least double for our highway (street) equipment if by so doing, we could increase their efficiency one hundred per cent or more. Before proceeding on that premise, however, it is well that we inquire into the correctness of these conclusions.

A thoroughfare operating at 100 per cent efficiency might be presumed to consist of any given number of travel lanes and upon which all lanes permit of continuous flow at whatever speeds may be deemed safe. For the moment, we are considering urban thoroughfares.

Such thoroughfares we discover are crossed at certain intervals by similar ones. At the intersections thus formed by two streets carrying maximum load, we find a condition where the intersection which is used jointly by both streets represents but 50 per cent of the pavement area otherwise employed along the open stretches. Theoretically, we might presume that the intersection therefore permits either approaching thoroughfare to employ it but half of the time. Practically, however, mechanical limitations become involved through the necessity of first clearing the intersection of traffic volume contributed by one thoroughfare and then the time required by the cross traffic to attain headway. The theoretical capacity of the intersection is thereby reduced in terms of a given vehicle by the 50 per cent dead period, plus the loss caused by deceleration in the approach and the following period of acceleration after the stop. The total subtraction from maximum operating efficiency will, of course, vary under local conditions but will probably average 60 per cent—leaving a balance efficiency of 40 per cent.

It may, of course, be argued that under ideal conditions of intersection spacing and complete synchronizing of intersection control, that continuous flow may be effected. Granted, but under such control, though the individual vehicle may operate at continuous speed and therefore greater efficiency, the capacity of the thoroughfares as such is not being fully utilized. Synchronized signal operation involves "wave" movement, consisting of a dense avalanche of vehicles surging forward, just beating the signals, but with a following void along the length of which the street facilities are out of use. Individual convenience is catered to, but the capacity of the thoroughfare as such is still measured by the neck of the hour-glass represented by the intersection.

There is another factor, however, that contributes to the difficulty. That is found in the service rendered abutting property by parking at the curb. Studies that have been repeatedly made uniformly reveal that the deterrent to traffic flow is greater than that represented only by the dormant lane of parked vehicles at the curb. The ever-present hazard of vehicles approaching or leaving the curb and the possibility of pedestrians popping out from between idle cars produces a No-Man's Land immediately adjoining the parked line and a lane of reduced speed adjoining that. What further subtraction from the efficiency of the thoroughfare results from this cause is difficult of determination but it is probably sufficient in certain cases to bring the remaining efficiency down to the indicated 30 per cent.

As this discussion purports to be popular rather than technical in the strict meaning of technical, our purpose will be best served by leaving our train of thought for the moment that we might consider some of our involved elements in another field.

We find certain interesting observations if we turn to the operation of transcontinental rail service. We discover first that the running time for crack passenger trains between Los Angeles and Chicago, for instance, is staggeringly short. This in itself is interesting. When we learn, however, that the rail line that carries these hurtling trains also accommodates the plodding local

freight and even the through freight, we stop to ponder how that can be possible. The explanation, of course, is found in the fact that regardless of the number of train units that may be strung across the country on the ribbon of steel, their movements are synchronized through a carefully worked out schedule of operation. Under this centralized control, the limited train thunders along over a constantly open track made so by the momentary side tracking of the slower trains ahead of it, which later fall in line again behind it. But synchronization through central control is the answer.

Now when we come into the realm of the motor vehicle, however, we find that practice impossible. If it were possible, wonders might be accomplished. But here we find that each driver is his own center of authority and there are as many "dispatchers" as there are cars and if passengers be in the back seat, we may double the number through "back-seat-drivers." System-wide synchronization, therefore, is out of the question.

The only alternative thus far devised is found in operating rules called law, and when urban congestion is involved, we add the medium of arbitrary mass control through manual regulation of either human or mechanical form. But as we do it, we remove ourselves farther and farther from the ideal of efficiency.

Now we come back to our main train of thought. Railroad practice is impossible as applied to the millions of mobile units. The "trackage system," which in this case is our highways, we find are deficient in two essential respects. They have intersections at grade and have barnacles along their edges. If we are now willing to be bold, we will accept these facts and conclude that having isolated the germ of our difficulty, we will defeat it by radical treatment—remove it!

I use the term "radical" as applied to the cure. One wonders, however, whether the radical condition is not found in the disease and that the cure is to be found by recourse to a rational recourse to simple mechanics. If there be soundness in that reasoning then, so far as our true highways are concerned, our task is to design them so as to completely eliminate the two physical weaknesses—intersections and abutting property! The proposal naturally raises the question as to whether it can be done. The answer is "Yes!"

But is it practical? Will it work if resorted to and how may it be accomplished in view of public opinion, economics and engineering?

The Cure

It may further serve our purpose to consider the evolution of our open highway to urban street. The primary form of our highways consists usually of a relatively narrow ribbon of pavement stretching across open country with only occasional intersections which also afford means of ingress and egress to our highway. At such points of intersection, we have multiplied accessibility by reason of adding the facilities of the transverse road to our highway. Locations at those centers therefore lend themselves to accommodating commercial services catering first to the passing traffic. These developments foster the additions of still different commercial enterprises that cater to the surrounding areas that have access over at least four approaches. The nucleus of a town develops with the inevitable expansion longitudinally along the highway of further urbanization. The highway now begins to take on the characteristics of a city street. The intersection now changes from the status of an intersection for lanes of through traffic and assumes the nature of a terminus for ever-increasing numbers of vehicles. Widening of the roadway usually follows but never to the degree of increasing through carrying capacity and always at an expense that raises the question of justification of such cost from the standpoint of through-traffic service.

This process is persistent. Not only do the number of impediments to continuous traffic develop, but the conditions in centers already established become more aggravated. The travel time over any highway thus affected becomes greater and greater until progress along them becomes one unbroken fight against delay and hazard to the point where the built-in efficiency of machine and driver is crippled.

We are therefore confronted with a situation where in spite of vast sums being expended, the utility of the highways is foredoomed to fail of their original purpose unless some basic change shall be made in their treatment that will be productive of results in efficiency that will be at least partially commensurate with the cost involved.

Again we are led to the conclusion from these observations that the service we desire from our highways can only be realized by recourse to a design that will effectively isolate our volume of through traffic from all types of impediments.

There seems no other solution therefore than that we must lay down our routes of travel as determined by the usual considerations and then proceed boldly to construct along such routes a ribbon of roadway that shall be effectively insulated from both cross traffic and abutting property.

These specifications demand that complete separation of grade shall be effected at points when cross traffic is required and that adjoining properties shall be served, when needed, by auxiliary parallel roads.

Described as a finished unit, such a highway in its simplest form would be a three-barreled roadway. The central lane, divided or not according to local conditions and desires, would be reserved exclusively for through traffic. It would be crossed only by important cross thoroughfares at reasonably long intervals and these crossings effected by an ultimate separation of grade with the express highway lane passing either over or under, according to dictates of local physical conditions. This central express lane would be physically separated from the auxiliary local and parallel roadways on each side by anything ranging from a simple curb to a parkway of optional width.

Local transverse streets would all be permitted to intercept the marginal road but none of them would be carried through or permitted to intersect the express lane. Crossings of the latter would be limited to streets of major local importance and, as already stated, even these crossings would ultimately be separated in grade.

Ingress and egress from the express lane would be afforded by "switch" cross-overs cut through the separating barrier between the express lane and the marginal roads in the vicinity of the major cross streets. Egress would be possible on the approach to the separated crossing. Ingress would be effected beyond the crossing. At no time would a left-hand turn along the express lane be permitted or possible.

In California, the plan already has three partial applications. The state highway leading north out of Chico incorporates the idea in a limited way. Kearney boulevard in Fresno employs the three-barreled roadway feature and in Los Angeles, the Whitnall highway plans contemplate the complete adoption of the principle.

Contrary to first impressions, this super-highway prin-

ciple is practical, would have certain practical economics in spite of the lands required and the ultimate construction cost of the completed unit. Recourse to the plan in existing urban centers admittedly involves more extreme practices than have been the custom thus far, with some exceptions. But when it is realized that the present methods, though costly, are not productive of the desired results and that under the super-highway form of treatment far fewer projects would produce much greater practical results, the serious question arises whether in its most extreme form the super-highway design would not prove the most economical on the basis of service rendered. That phase of the subject is susceptible of thorough and satisfying analysis but as it does not constitute the principal burden of this discussion, it will not be further carried out at this time.

It is important to note, however, that except in existing urban centers the development of such a system lends itself to a natural evolutionary process once the plan is definitely determined upon. In California, as an example, the present eighty-foot highway right-of-way offers the complete requirement for the ultimate express lane. Along the open stretches, the present roadway offers a carrying capacity usually greater than the full street width in urban centers. The additional unpaved width remains available for ultimate needs.

The marginal roadway remains entirely unnecessary until abutting properties warrant development. Local requirements may then provide for the dedication of this local street in exactly the same manner that the customary dedications are now made for the ideal type of transverse or parallel local street. In short, the adoption of the physical plan would carry with it the providing by highway departments of the continuous express lane width to be all developed as such a necessity demands, provided that the local marginal street be made available through local agencies.

The physical plan presupposes the complete financing of the express lane and appurtenances out of general highway funds. Though immediately contacting the local systems of streets, it remains permanently and physically divorced from them. No degree of adjoining urbanization would cripple the efficiency of the express lane highway. Though geographically contained within the physical limits of urban areas, from an operative standpoint complete isolation would result. In this respect, such express highways would be immune to surrounding congestion just as present rapid transit rail lines enjoy regardless of the methods employed.

Before considering the influence of such unobstructed traffic facilities upon community design and urban life it is well to give some thought to an objection that suggests itself. The question arises whether the interruption of local street networks by terminating such thoroughfares at the super-highway would not introduce a disadvantage greater than the benefit to be derived from uninterrupted through traffic flow. This might apply especially to pedestrian crossing of the super-highway. The blunt answer is that one cannot expect all desirable facilities when among them are found some that naturally conflict. It becomes a matter of selecting the most essential. The constructive answer is to be found, however, in analyzing the tendencies of urban development that would be influenced by the introduction of unobstructed traffic through the dense maze of present urban districts. It is fair to assume, however, with respect to local streets that with the introduction of adequate facilities for rapid through traffic, the local thoroughfare will naturally be limited to the sole function of affording access to abutting frontage. Any occasional inconvenience to a local resident will be more than compensated for by a natural elimination from local streets of all traffic volume save that alone required to serve the individual street. It must be observed that under the present system, the inadequacies of so-called major streets compel the utilization of local streets to accommodate the overflow and by-pass traffic. Under this practice, traffic is inadequately accommodated and the areas penetrated by the resulting grouping traffic volume are relatively destroyed for the otherwise logical non-commercial uses. The present situation is graphically illustrated by a low swamp area saturated by spread outs, semi-stagnant waters, suited neither to uses as land or water because of the mixture of both. Into many such actual conditions, the introduction of deepened, straightened and unobstructed drainage channels has resulted in the most valuable reclamation of highly productive lands. The comparison between the swamp and water with the average urban area and traffic is so striking that further comparison of the results of "draining" by adequate "open channels" is probably unnecessary. Though this discussion is concerned primarily with the mechanics of highways and traffic movements, the fact is not overlooked that adequacy of highway and traffic facilities is but a means to the end of catering to modern social requirements. It is not sufficient, therefore, that we limit considerations to mechanics alone. Economic limitations and related community requirements inevitably introduce elements tending to compel compromise with pure mechanical efficiency. Certain phases of economics have already been touched upon as have the purely local community considerations. There is another broader influence worthy of study as affording an additional factor by which to judge the soundness of the super-highway proposed. The term "super-highway" so adequately defines the type of thoroughfare here discussed that it is employed notwithstanding its use elsewhere in referring to certain prominent thoroughfares, as in the Detroit and Milwaukee areas. It might be mentioned in passing that Detroit's Woodward avenue and Milwaukee's Blue Mound road are "super" in their over-all width but beyond that, they are but overgrown double streets possessing all of the inherent weaknesses of mixtures of local and through traffic, abutting frontage, dangerous and retarding intercepting and intersecting cross traffic.

In short, the ideal super-highway is one so designed as to permit the scrapping of most man-made traffic laws and the substitution of nature's laws of mechanics or physics.

The combination of highway facilities capable of releasing the potential permanence built into the modern motor vehicle, plus the high degree of saturation of autos in population would give to the latter so much of the quality of a fluid that the effect upon the condition of urban life staggers the imagination. Suffice it to say in conclusion, lest the intriguing possibilities tempt us to romancing in a limitless field, that not until facility of individual and mass movement is made possible will urban development be stripped of its present artificial limitations. Just what normal population density consists of or what degree of distribution of industry lends itself to the most efficient and economical operation is a thing never yet determined, because the limitations of access and circulation have always imposed such heretofore insurmountable difficulties that every adjustment thus far has been in some large degree a combination of compromises.

De-celerating Intersection

By W. S. Foster,
Iowa State College, Ames, Iowa

THOUGH not the customary procedure, there is at least one intersection designed purposely and intentionally with the idea of slowing down traffic. Also, after nearly a year's trial, it has shown itself to be worth the effort.

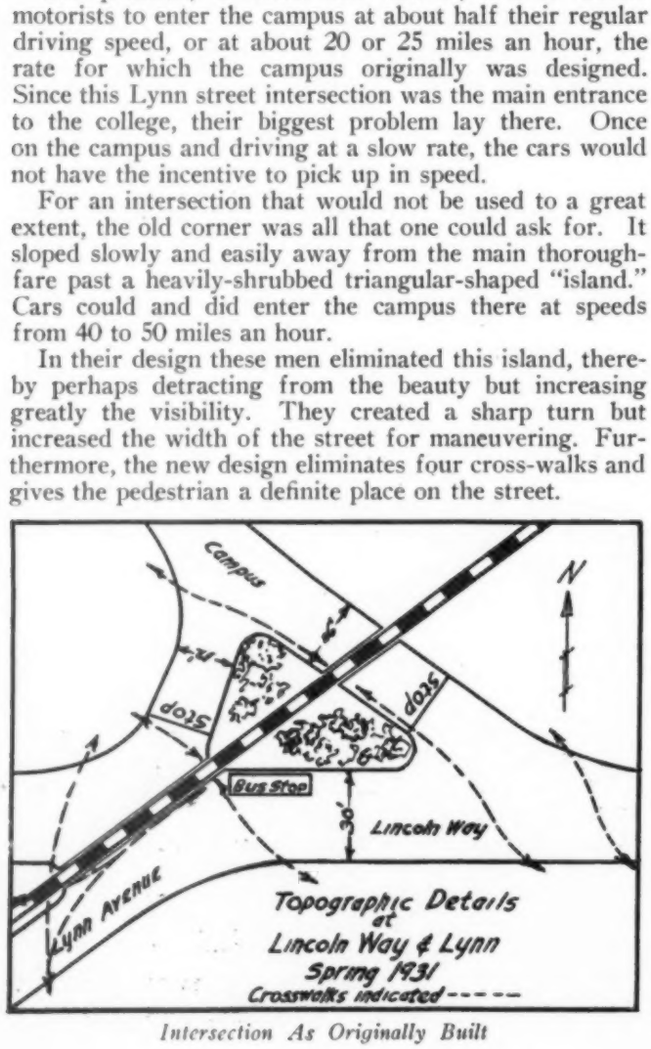
The peculiar design of this intersection, forming one of the south entrances to the Iowa State College campus, literally was forced upon its authorities. This college, long noted for its artistic campus, has had one serious drawback, that of narrow, winding, and dangerous drives, reflecting the influence of the original horse-drawn traffic. During the college year 1930-1931 three men lost their lives on the campus by auto accidents, one of the more serious accidents being at this intersection. Minor accidents were common and traffic jams were the expected thing during the noon-hour rush.

The men appointed to solve this problem were: T. R. Agg, dean of the Engineering College and widely known highway authority; Prof. R. A. Moyer of the Highway Engineering Department, and Prof. P. H. Elwood, head of the Landscape Architectural Department.

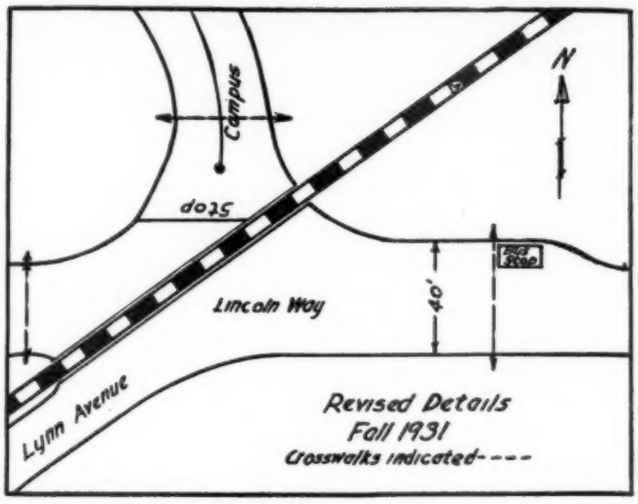
The problem, as these men saw it, was to induce motorists to enter the campus at about half their regular driving speed, or at about 20 or 25 miles an hour, the rate for which the campus originally was designed. Since this Lynn street intersection was the main entrance to the college, their biggest problem lay there. Once on the campus and driving at a slow rate, the cars would not have the incentive to pick up in speed.

For an intersection that would not be used to a great extent, the old corner was all that one could ask for. It sloped slowly and easily away from the main thoroughfare past a heavily-shrubbed triangular-shaped "island." Cars could and did enter the campus there at speeds from 40 to 50 miles an hour.

In their design these men eliminated this island, thereby perhaps detracting from the beauty but increasing greatly the visibility. They created a sharp turn but increased the width of the street for maneuvering. Furthermore, the new design eliminates four cross-walks and gives the pedestrian a definite place on the street.



Intersection As Originally Built



Intersection After Improvement

It irked the car-owners at first. Iowa had been building long, smooth roads superelevated so that the cars almost turned by themselves; and drivers didn't like the idea of this abrupt corner.

As final "proof of the pudding," the hospital reports that auto accidents on the campus have been reduced by 75 per cent.

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Most Feeder Roads Are Yet to Be Built

The progress made in building the system of main highways of the United States has not been duplicated in the feeder roads that serve the main highways, declares T. H. Cutler, president of the American Road Builders' Association. He believes there is a tremendous task of road building ahead.

"Just as the trunk of a tree will not survive without branches and twigs, similarly the feeder roads are essential to the proper functioning of our highway system," he stated. "Completion of the main roads is just the beginning of the ultimate highway system.

"What work remains to be done on the highway system? Additional routes must be provided to care for unusual traffic conditions. Many routes must be widened. Safety features must be built into existing roads. Belt lines must be built. Pavements built years ago to fit traffic conditions then existing must be reconstructed. Gaps in the main system must be filled in. All this work and more remains to be done on the main systems besides the work of meeting unpredictable changes and improvements in motor vehicles.

"Many localities are not adequately served with feeder roads that can be traveled at all seasons of the year with economy, comfort, and safety. These inadequate feeder roads must be surfaced so that the loads hauled on the main highways can be carried over the feeders without reducing the loads or damaging the vehicles.

"Highway transportation is going through much the same cycle of development as railroad transportation. Lines built to connect population centers are joined to form main trunk lines. The main trunk lines are served by branch lines or feeders, so that commodities and passengers can be hauled economically, comfortably, and safely into all parts of the country.

"In the early days railroads were built single track. Now many of them have multiple tracks to care for the traffic. Similarly, single track highways built in the early days are becoming multiple track lines to provide for the traffic."

Emulsified Asphalt Runways Completed At Dallas Airport

By Richard B. Koss,
Pre Cote Sales Company, Dallas, Texas

A SYSTEM of all weather runways has recently been installed at Love Field Airport, owned and operated by the City of Dallas, Texas. They are laid out in eight directions, permitting landings and take offs under every wind condition. The system was constructed at a cost of $120,000, excluding drainage, etc., and brings the total investment made by the city at the airport in excess of $800,000.

During the World War, Love Field was used by the army as a flying school for training army pilots. The field was later purchased by the city, with additional land, at a cost of $325,000. The original field covered one hundred and sixty-seven acres, and in 1931 the city purchased ninety acres more for $140,000, making a landing area of two hundred and fifty-seven acres.

Location.—The airport is located northwest of Dallas, about five miles from the business district. Passengers are carried to and from the airport by fast busses operated by the local traction company and special cars owned by the operating airlines. There are factories on two sides of the field but are low and without high chimneys which would serve as an obstruction to air navigation. The adjacent land on the other two sides is being developed into residential lots. It is not considered possible at present that additional land will ever be needed for the landing area.

The landing area is naturally flat. The soil is black dirt and has poor drainage characteristics. In order to make the airport effective for air travel in all weather conditions it was absolutely necessary to provide adequate drainage and surfaced runways. At one time in 1931 there were fifty scheduled flights a day, included in which were several flights of tri-motored ships operated by the United Air Lines and American Airways. The Bowen Company, an independent operator, used Lockheed Vega planes with a high landing speed. Two of the operators desired to inaugurate night passenger service, requiring every possible safety factor on the ground.

Selection of Type.—It was not considered economical to install artificial drainage throughout the entire landing area, in view of the fact that only the runways themselves would be used in inclement weather. Accordingly exceptionally long runways were laid out in each direction, with adequate drainage provisions for the runways themselves. The system as constructed included four surfaced runways, each 100 feet wide, and converging at the center of the field to form a hub containing six solid acres of surfaced area. The length of the runways averages four thousand feet each, the longest slightly exceeding five thousand feet.

Runway Numbered for Identification

Plane Standing at Left of Runway

Plans called for the surfacing of 150,000 square yards of runways and the first problem of the city engineers was the selection of a type of surfacing which could be constructed within the funds available. At the same time the pavement had to be durable enough to withstand the abrasive action of tail skids and heavy loads transmitted through the wheels of the planes. The average trimotor transport airplane at present has a gross weight of approximately 13,500 pounds. An accurate method of measuring the impact produced by airplanes in landing has not been devised. Studies have been conducted on this subject by the Department of Commerce and tire manufacturers which give an indication of the approximate impact values that may be expected. In general the total impact, or the sum of the static and dynamic loads, of an airplane in landing is equal to from 1.5 to 2.5 times the static load.

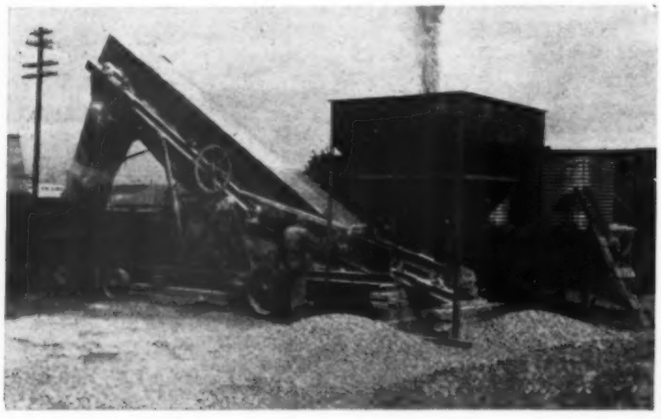
Specifications.—After taking the various requirements into consideration the engineers selected a bituminous surfacing on a base of native "white rock" stone. The base course was laid to a thickness of six inches after compaction, upon the black dirt subgrade. The white rock used for the base course was the best obtainable from local pits, free from soap stone, disintegrated stone, shale, or similar material. The stone was not larger than twelve inches in its largest dimensions.

The white rock was dumped from trucks and placed upon the prepared subgrade by hand and broken with sledges until there were no stones near the top of the course larger than six inches. When the sledging had been finished the surface was rearranged to insure a uniform distribution of the material and all voids were filled with spalls. The base was then thoroughly rolled with a ten-ton three-wheel roller. Any irregularities or depressions that appeared after this rolling that exceeded one-half inch when tested by a ten-foot straight edge laid paralleled to the center line of the runway was corrected before the bituminous top was placed.

Surface Course.—Upon the base course as previously described there was spread crushed limestone aggregate precoated with emulsified asphalt. The emulsion was made at a railroad siding located less than a half mile from the airport. Straight asphalt of ninety-six penetration was shipped from the Texas Company refinery at Port Neches, Texas, to the siding. Here it was heated

by a 40 hp. high pressure boiler and converted into emulsion by means of a portable emulsifying unit.

In order to insure a complete and accurate coating of emulsion on the stone and to avoid any delays due to mixing the aggregate with emulsion after placement on the runways, the two materials were pre-mixed at another portable plant located about 200 feet from the emulsifier. As shown in the picture, the emulsion is piped into a vat at the bottom of the immersion machine.

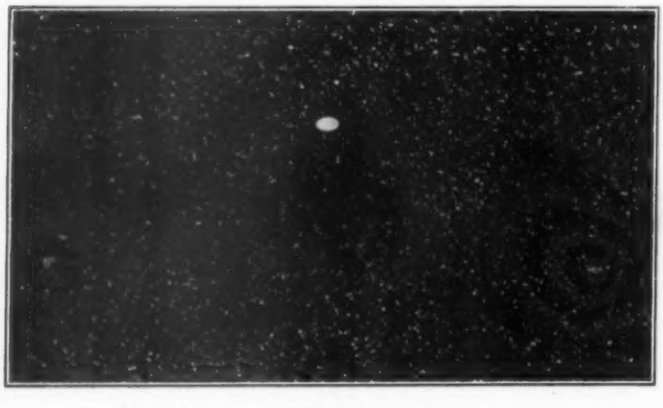


Pre-Cote Machine Used for Making Bituminous Mixture

Its flow is regulated by a valve at the hand of the operator, who has a full view of its contents. Crushed limestone is fed by means of a crane into the hopper located at the rear of the machine, and carried by means of a short iron conveyor into the vat of emulsion. Here it is immersed in the liquid bitumen, receiving a slight excess of the bituminous material.

It is then lifted from the vat by bucket elevator, allowing thirty seconds drainage before being discharged into the waiting trucks. Two-ton trucks were loaded every three minutes and a single day's production often exceeded four hundred tons of coated material. As soon as the trucks were loaded they proceeded across the field to the runway under construction. At no time was there any delay to the air traffic. The base course was laid as soon as a section of subgrade was ready for the material, as much as 3,000 square yards being laid in a day.

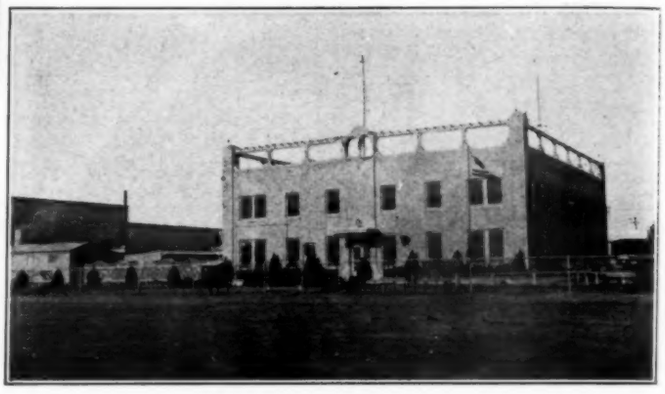
Trucks immediately followed with the stone coated with emulsified asphalt. The stone was graded evenly from one and one-half inch to one-half inch. It was spread by a crawler tractor pulling a 12-hp. blade, and given an initial rolling the same day. The next morning the surface course was given another rolling, after which it was ready for emergency traffic. When the pavement had obtained a good set it was covered with ten to twenty pounds of limestone chips per square yard. The chips were broomed into the surface voids with a broom drag attached to a light truck. They were then penetrated with .25 gallons of emulsified asphalt by a pressure distributor. The finished surface was then given a final rolling.



Character of Finished Surface

In order to clearly mark the runways for night flying a two foot wide white stripe was painted along the edges of the runways. The runways were also numbered to facilitate radio communications between plane and airport. At no time has the surface shown signs of ravelling or disintegration due to the abrasive action of tail skids with which most student planes are equipped.

Runway Drainage.—To carry off surface and sub-surface water, surface intercepting drains were installed parallel to the runways at a distance of fifty feet from the edges. The drains varied in depth from two to six feet and approximately two feet wide. At the bottom of the drain 10-inch perforated corrugated pipe was imbedded in crushed limestone. The limestone was carried to the surface of the field, and penetrated with emulsified asphalt to bind the particles together. Due to the large size of the aggregate used an effective drain was obtained, which served the purpose of collecting surface water, a storm drain, and a sub-surface drain. Iron manholes were installed at frequent intervals.



Headquarters Building

Other Improvements.—Other improvements at the airport include a $50,000 brick apron in front of the hangars, a $30,000 lighting system, and $20,000 roadways. The airport is one of the largest in the country from the standpoint of size and total investment. All plans were drawn at the city engineer's office under Mr. O. H. Koch, Director of Public Works.

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HIGHWAYS IN INDIA.—British India, including Punjab, has about 225,280 miles of highways and roads. Of these 64,007 are waterbound macadam; 1,030 surface-treated with tar, bitumen or asphalt; and 160,243 low type, unimproved. While statistics are not available for all the native states in India the more important ones have a total of approximately 4,311 miles of earth and 8,454 of macadam. There were 170,429 motor vehicles registered in India (including British, French and Portuguese India, and the native states) at the end of 1931. These consisted of 114,609 passenger cars, 43,577 busses, and 12,243 trucks.

Highway Grading *Specifications* Need Revision

Suggest Borings Should Be Employed to Determine Character of Subsoils

By LOUIS E. WOOTEN

Associate Professor of Civil Engineering, North Carolina State College

SPECIFICATIONS used in contracts for highway excavation fail to carry the same degree of accuracy, precision, and consistency which prevail generally in other accomplishments of the engineer. Vagueness in description and illogical classification of items too often result in arbitrary interpretation by the engineer and dissatisfaction with the estimates for payments due the contractor.

A study of the general specifications of ten different state highway departments reveals many radical differences. The variety of the grading work in these states obviously covers practically the same range of materials, yet one of these states provides for fourteen separate grading items, while two others provide for only three. The other seven states range between these extremes. The states covered in this study are Connecticut, New York, New Jersey, Pennsylvania, Virginia, North Carolina, South Carolina, Tennessee, Illinois, and Wisconsin. The geographical location of states seems to have only a minor influence with regard to uniformity of specifications.

For purposes of comparison grading will be considered as falling into two general groups:

1. Classification according to the relative position of the material.
   - a. Roadway.
   - b. Structure.
   - c. Ditches.
   - d. Borrow.
   - e. Overhaul.
2. Classification according to the character of the material.
   - a. Earth, or common excavation.
   - b. Solid rock.
   - c. Loose rock.
   - d. Wet excavation (for structure).

Seven of the ten states provide an item for structure excavation. Pennsylvania, North Carolina, and Illinois are the exceptions, and these three provide for it indirectly. Pennsylvania carries it as "Class Two," which includes hand excavation, usually anything below subgrade. North Carolina provides for additional payment when the structure is carried below the grade shown on the plans. Illinois allows additional payment when rock is encountered.

A separate item is allowed for ditches and channel changes by New York, Pennsylvania, North Carolina, and Wisconsin. In Pennsylvania it is paid for as "Class Two." In Wisconsin the two are separated into distinct items.

Provision for borrow is made by eight of the states, Connecticut and New York being the exceptions. In both of these the contractor is required to furnish at his own expense any additional material required for completing the embankment, and payment therefor is made at the same unit price as for roadway excavation. In New York the material is measured in its original position, while in Connecticut the quantity is determined by the difference between cut and fill, with an allowance of 15 per cent for shrinkage of earth.

Overhaul is allowed, and paid for separately, by seven of the states. The exceptions are Virginia, New Jersey, and Connecticut. Wisconsin allows overhaul only on borrow. The free haul limit in the various states ranges from 500 to 2,000 feet.

Virginia and Pennsylvania are the only states which make no distinction as to the character of material. Five of the other states carry an item for rock. Illinois, Wisconsin, and New Jersey carry two items, "solid rock," and "loose rock" or the equivalent of these terms.

Tennessee and Connecticut carry an item for "wet excavation." Wisconsin with six items for structure excavation does not provide for wet excavation.

There Is No Doubt But That Test Borings Would Indicate This Job at Saugerties, New York, to Be All Rock Classification

Wisconsin is the only state providing for "marsh excavation."

Grading for pipe culverts is paid for separately in only two of the states. In New York it is carried as a separate item, and in Tennessee, it is carried as "unclassified." In all of the other eight states pipe culverts are paid for by the lineal foot "in place."

South Carolina alone provides a separate item for drag line embankment.

Seven of the eight states providing for rock excavation place the minimum volume as one-half cubic yard, while North Carolina has a minimum of one cubic yard.

There is a wide difference in the wording of the specifications for solid rock as employed by the several states.

In Tennessee the specification is "All rock in place which rings under the hammer, or which can not be excavated without the use of explosives, or which can not economically be excavated without a power shovel."

Connecticut's specification is "Rock in ledge forma-

tion, the removal of which requires wedging, barring, or the use of explosives."

New York's specification is "All ledge rock and other material which is determined by the engineer to be so hard that it is not practicable to loosen and handle with a power shovel except by preliminary blasting."

The specifications in Illinois and Wisconsin are unique in that they are identical for both classes of rock. Solid rock or "Class C," "Shall include all boulders and rock measuring one-half cubic yard and upward; all solid or ledge rock in removing which it is necessary to resort to continuous drilling and blasting." Loose rock, or "Class B," is "Material which without first being loosened by other means can not be reasonably plowed with a heavy railroad type mold board plow pulled by adequate power, but which can be removed with heavy machinery without blasting, even though blasting may be resorted to in order to facilitate handling."

The foregoing serves to show the marked contrast between the various state specifications. This contrast occurs in the detailed working no less than in the general form into which the number of items are divided. Many of these differences are vital in character, while, of course, others are of a minor nature.

Deviation from these standards are sometimes made by special provisions in the proposal, but such exceptions are somewhat rare, and in no way serve to bring about more uniformity.

With this wide divergence of specifications and methods of determining the amount of payments due contractors it is obvious that there is room for much needed improvement. Specifications free from ambiguity, and methods of payment eminently fair to both parties constitute an obligation which highway engineers might well heed.

The advantages of the unit bid are well understood by all engineers and highway officials. This method permits an increase or decrease in any of the quantities without any undue risk being placed upon either party. This advantage is almost wholly lost, however, when the contractor receives the same unit price for such items as solid rock, small drainage ditches, and large quantities of common excavation.

When such widely different types of work are thrown into one item it has the effect of the lump sum bid. Rock excavation may cost as much as two or three dollars per cubic yard, while common excavation favorably located may be moved for 30 to 35 cents.

The unfairness of including two such types of work at the same unit price is accentuated by the fact that in nearly every contract some changes in plans or quantities are made. The result of such changes is that the contractor never knows which way these changes will affect him. If the more expensive features are increased in greater portion than the inexpensive features the contractor will lose, while if the order is reversed the state becomes the loser.

In a similar manner other types of work are thrown into one item, changes in the anticipated quantities are brought about, unforeseen losses are suffered, and the idea of the unit bid is violated. Successful contractors after such losses soon learn to boost their bids so as to take care of these probable changes. The final result is an increase in the unit bid price. The other extreme, that of providing too great a number of classifications, also presents serious difficulties. For example, when roadway quantities are divided into common excavation, loose rock, and solid rock, it is generally impossible for the engineer to determine how much of each is removed in cases where all three occur adjacent to each other. If rock lies underneath earth it is usually stipulated that after the rock has been stripped of all overlying earth the contractor shall notify the engineer who shall then take profile levels and cross-sections before any of the rock shall have been removed. Not only does this procedure involve expensive delay, but it often interferes with the contractor's plans for the method of excavating.

It sometimes happens that rock is on the surface, with earth underneath. After the excavation is begun in such cases it is utterly impossible for the engineer to determine with assurance the respective quantities of the two types of material.

These difficulties are not experienced, however, when additional items relating to the position of the material are provided. For example, if a separate item for drainage ditches is provided, the quantity to be allowed for payment is susceptible to measurement and accurate determination, and no additional work is imposed upon the engineer.

On the Surface, This Work Would Appear to Be a Dirt Moving Job

If a solution for these difficulties is to be found it will come only after more thorough surveys and more complete plans are made, and when these plans are adhered to more closely. The location survey should definitely determine the final location in every detail. Profile levels and cross-sections should be complete and accurate, thus permitting the establishing of grade lines which will produce known quantities of excavation prior to letting the contract.

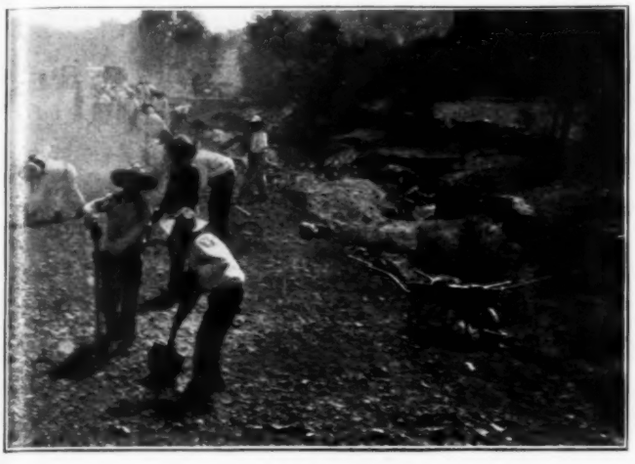
Comprehensive borings over the areas to be excavated should be made for the purpose of determining the character of material to be removed. This is a departure from present highway practice, but it is the only means by which either party to the contract may know the character of the material to be encountered or the extent of the work to be done.

Where ordinary earth is found the borings need not be taken at close intervals and the expense thereby incurred will be of little consequence. Where rock or other difficult material is found more investigation will be required, but this preliminary expense will be more than offset by the acquirement of definite data bearing upon the nature of material.

This method would permit all contractors to bid on a

uniform basis, enable them to predetermine the most effective methods to be employed, eliminate the greater part of guess work, obviate endless dissatisfaction and confusion between engineer and contractor, and no doubt, finally serve to bring about lower bids.

The exact location of all structures should be determined, elevations should be taken and borings should be made. From this data the quantity of excavation should be calculated, and the character of the material as determined by the borings should be shown on the plans.



Common Excavation with Pick and Shovel

Exact quantities for the various classes of materials need not be guaranteed, but the accuracy and truthfulness of the data obtained from the borings should be guaranteed.

The size, elevation, and exact location of all pipe culverts should be determined and shown on the plans. There is no reason why this data can not be finally determined prior to letting the contract. Yet in some states the resident engineer delays the contractor in giving the location and grade, or alters the size of pipe required, and in some cases adds new pipes to those shown on the plans, or even eliminates some of those so shown.

When the surveys and plans are completed as above outlined the method for determining the number of grading items is simplified. Only one classification relating to the character of materials is now necessary. The contractor will know what grade of materials will be encountered, and where each is to be found. Quantities of excavation and embankment will not differ widely and the small amount of waste or borrow will be of no serious consequence. Under these conditions the unit bid price will constitute a fair method of awarding the contract and for determining the amount of payments due.

Extra pay for excavation for pipe culverts would be wholly unnecessary. The price per lineal foot for pipe "in place" could be made to cover the cost of grading without undue risk.

Likewise an item for excavation for larger structures would be unnecessary. With the quantity and character of materials known the contractor would be enabled to allow for excavation in his price on the other items. This would eliminate the work of the engineer in "measuring up" and determining estimates for structure excavation. If it were desired to provide part payment as the work progresses the excavation for each structure could be let as a lump sum.

It seems desirable to segregate ditches and small channel changes as separate items. There is a great difference in cost between this class of work and that of earth which can be removed by steam shovel. This type of excavation is clearly segregated from the remainder of the excavation. Therefore, when it is classified separately, no additional field work is imposed upon the engineer, and little, if any, additional office work.

Borrow is likewise a separate entity, and therefore may be carried as a separate item without additional work on the part of the engineer.

Overhaul is always a source of much confusion and dissatisfaction. Most of the specifications for this item are rather vague. What the legal interpretation would be is a matter of conjecture.

Where the plan quantities are reliable, overhaul on roadway excavation should not be employed. The Wisconsin plan of allowing overhaul only on borrow seems to be the proper solution.

It is commonly believed that quantities properly balanced on the plans fail to balance in construction. A great discrepancy here would tend to weaken the methods above outlined. This discrepancy is generally attributed to the variable shrinkage factor of earth, or the swelling factor of rock. The error due to these factors, however, is probably far less than that due to inaccurate levels, cross-sections, and calculations, and the waste in handling and placing of materials by the contractor. Much material may be wasted during the hauling, or in making the foot of embankments too wide, or in disposing of stumps and roots.

Probably the most satisfactory method of controlling this problem is the plan used in Connecticut where the contractor is required to complete the embankment shown on the plans, with a stipulated shrinkage factor.

Grading Operation Requiring Moving of 250,000 Cu. Yds. of Earth in 3 1/2 Miles of Highway.

It is proposed that excavation be divided into the following items:

1. Roadway.
2. Ditches and channel changes.
3. Borrow.
4. Overhaul (borrow only) optional.
5. Bridge excavation, lump sum for each structure.

▼

RAILWAY SUBSTITUTES BUSES FOR TRAINS.—Motor buses will take the place of six more passenger trains of the Chicago, Burlington & Quincy R. R. in Illinois. The buses will be operated by the Burlington Transportation Co., a subsidiary of the railroad, at an annual saving, it was estimated, of $11,000.

"WESTWARD HO!"

TOURING in the early decades of the 18th century. Philadelphia to Pittsburgh in 20 days.

TOURING in the early decades of the 19th century. Philadelphia to Pittsburgh in 5 days.

The 1932 Method

Multiple Sizes of Coarse Aggregate in Concrete Paving

DURING the summer of 1931 an investigation was conducted by the Minnesota State Highway Department and the Division of Management of the U. S. Bureau of Public roads for the purpose of studying the use of multiple sizes of coarse aggregate in the construction of portland cement concrete paving. Five projects were studied in Redwood, Renville, Nobles, Milaca, Fillmore and Sibley Counties, Minnesota. The features studied were the uniformity with which the gravel, sand, cement and water composing the concrete were distributed throughout the batch, and the cost of handling the three sizes of coarse aggregate as compared with one size of coarse aggregate. Some interesting information on the results of the investigation was given by T. C. Thee, Assistant Highway Engineer, Division of management, in a paper presented before the Minnesota Federation of Architectural and Engineering Societies. The notes following are taken from Mr. Thee's paper:

Securing Sample of Concrete.—In determining the uniformity of the distribution of the gravel, sand, cement and water, a piece of tar paper 3 ft. square was placed on the subgrade and its location carefully noted. After the first trip of the finishing machine a 4-sided metal cutter was placed over the position of the tar paper and pressed down through the fresh concrete until the paper was reached. The contents within the cutter were then entirely removed with a shovel and placed in a clean metal receptacle. The tar paper was used so that no appreciable amount of water would be lost to the subgrade and so that no foreign matter from the subgrade would be secured with the concrete in taking the sample.

Determining Uniformity of Distribution of Aggregates.—Immediately 25 lbs. of the removed concrete was weighed out on a 35-lb. scale sensitive to 1/16 ounce. After carefully adjusting the weight in air to exactly 25 lbs., the sample was weighed under water. It was then placed in a nest of sieves consisting of one No. 4, one 48-mesh, and one 100-mesh and washed over a large tub in order to retain all of the wash water. The material retained on the No. 4 sieve was classified as coarse aggregate, and that retained on the 100-mesh sieve as sand. The weight of the sand was later corrected to include the weight of the material passing the 100-mesh sieve and the weight of the cement was later corrected to include the weight of the material retained on the 100-mesh sieve. This material was first weighed under water, then air dried, weighed and subjected to a sieve analysis. The sand was also weighed directly under water. The weight of the cement under water was then computed by obtaining the difference between the weight of the total sample under water and the sum of the corrected weights of the gravel and sand under water.

The weight of the cement in the sample was checked by permitting the cement washed from the sample to settle in the tub and weighing the cement thus collected under water. The weight of the water was obtained by taking the difference between the total sample, or 400 ounces, and the sum of the weights of the gravel, sand and cement. The specific gravity of the gravel and of the sand was obtained daily for each sample taken.

The percentage of moisture in the aggregates was obtained from the tests made at the plant by the state. A sample of sand was taken from the trucks at the mixer during each series and washed through a nest of sieves to determine the correction factor for the material passing the 100-mesh sieve. A standard 6 by 12 concrete cylinder was made according to methods adopted by the American Society for Testing Materials from each sample taken from the road.

Each series consisted of five samples with each sample taken about 10 to 15 ft. apart longitudinally along the fresh concrete paving. A total of 122 series of five samples each were taken, which represents a grand total of 610 wash samples and a total of 610 cylinders, which should give a fairly true conception of the uniformity with which the gravel, sand, cement and water is distributed throughout the concrete, as well as some indication of the relation of this distribution to the compressive strength of the concrete as shown by the test cylinders.

On state-aid project 14-24 in Redwood and Renville counties a section of this project was paved using for the coarse aggregate gravel; a second section using limestone and pea gravel; and a third section using limestone. These coarse aggregates were separated into three sizes of from 2½ to 1¼ ins., 1¼ to ⅝, and ⅝ to ¼.

On projects 9-23 in Nobles county, 18-23 in Milaca county, 20-24 in Fillmore county, and 14-23 in Sibley county, only one size of coarse aggregate was used.

Summary of Data Collected.—Table I is a brief summary of the data collected on the five jobs, showing for each the number of sizes of coarse aggregate used, the identification of the job, the type of material and its source, together with the average percentage of gravel, sand, cement and water as determined by the wash test as well as the percentage of each of the four ingredients as intended by the design. The computed variation factor for the gravel, sand, cement and water as well as the average of the four ingredients is also shown.

This so-called variation factor was developed to study the amount of variation in a series of five samples. This variation factor has been computed as follows: The percentage of gravel, sand, cement and water for the five samples has been averaged and the arithmetical average of the percentage of variation of each of the four ingredients in a sample from the average of the like ingredients for the batch when expressed as a percentage, equals the variation factor for the sample. The larger the number, the greater the apparent non-uniformity. A similar variation factor was also computed for the series to indicate the variation of each ingredient from the percentage intended by the design.

Following in the table after the variation factor are the cement and water factors as computed from the actual cement and water contents found from the wash test. The workability factor b/b_o was computed from the gravel content determined by the wash test of the sample. The average of all the sieve analyses made of the coarse aggregate was obtained from the wash test of the samples. Since there obviously would be a variation of the percentage of the different sizes of coarse aggregate, a variation factor was also computed from the sieve analysis. The largest variation factor of 3.59 per

cent was obtained in the Sibley County job, where one size of coarse aggregate was used. The multiple sizes studied on the Redwood and Renville County job had the next largest variation factors—3.55, 3.47 and 3.18 per cent, respectively. The single aggregate jobs in Milaca, Fillmore and Nobles counties had the lowest variation factors of 2.85, 2.71 and 2.03 per cent, respectively. Even though there is a difference of 1.56 per cent in the variation between the minimum and maximum variation factor, all the variation factors are exceptionally good, considering other jobs that have been similarly studied.

The same directing personnel conducted the tests on all the jobs, using the same care in sampling, weighing and testing.

Comparison of Variation Factors.—The Milaca County job where one size of coarse aggregate was used together with the sand from a local pit, shows the largest variation factor as between the values determined by the wash tests and the values actually called for by the design. This large variation factor of 5.43 per cent was caused by the variable amount of sand carried by the gravel and again by the variable amount of fine gravel present in the sand. This is shown by the fact that for this job the sand design variation factor of 8.74 per cent was more than twice the average sand design variation factor, as well as by the fact that the gravel design variation factor was also high, being 5.74 per cent.

The compressive strengths for the jobs cannot be compared directly, because of the fact that different brands

TABLE I.—GRAND SUMMARY OF RESULTS OF THE STUDY OF MULTIPLE SIZES OF COARSE AGGREGATE AND ONE SIZE

	Three Sizes of Coarse Aggregate			One Size of Coarse Aggregate			
Project No.	State-Aid Project 14-24 Redwood and Renville Counties Limestone and			S.A.P. 9-23 Nobles Co.	S.A.P. 18-23 Milaca Co.	S.A.P. 20-24 Fillmore Co.	S.A.P. 14-23 Sibley Co.
Type of Material	Gravel	Pea Gravel	Limestone	Limestone	Gravel	Gravel	Gravel
Source of Material	Minneapolis	Minneapolis	Minneapolis	Mankato	Local Pit	Winona	Minneapolis
Actual Per Cent Materials from Test—							
Gravel	50.65	47.17	45.77	40.87	45.07	49.02	48.33
Sand	30.12	33.04	33.62	36.44	34.69	30.54	31.92
Cement	13.13	13.33	13.54	14.96	13.77	14.27	13.45
Water	6.10	6.46	7.07	7.73	6.47	6.17	6.30
Per Cent of Materials by Design—							
Gravel	49.44	47.01	45.72	42.72	47.69	49.62	47.45
Sand	31.20	33.08	33.79	35.32	31.92	30.19	32.21
Cement	13.15	13.18	13.48	14.44	13.95	14.29	14.08
Water	6.21	6.73	7.01	7.52	6.44	5.90	6.26
VARIATION FACTOR FOR EACH INGREDIENT OF TEST AVERAGES							
Gravel	2.99	3.11	3.59	2.12	2.39	2.16	3.31
Sand	3.53	2.89	3.23	1.80	2.32	2.35	3.51
Cement	3.38	3.55	3.53	2.18	2.37	3.52	3.27
Water	3.97	3.17	3.85	2.02	3.32	2.81	4.29
Average	3.47	3.18	3.55	2.03	2.85	2.71	3.59
VARIATION FACTOR FOR EACH INGREDIENT FROM DESIGN							
Gravel	4.07	3.61	4.00	4.63	5.74	2.76	4.18
Sand	4.99	3.72	3.63	3.96	8.74	3.54	4.14
Cement	4.14	4.10	4.26	4.11	3.48	4.43	5.73
Water	5.55	6.00	5.41	4.22	3.77	5.81	4.91
Average	4.69	4.36	4.33	4.23	5.43	4.14	4.74
Cement per cu. yd.	5.88	5.89	5.93	6.45	6.17	6.31	6.02
Water per sack of cement	5.25	5.48	5.90	5.84	5.31	4.89	5.29
Gallons of water per cu. yd.	30.9	32.3	35.0	37.6	32.7	30.8	31.7
Sand-cement ratio	2.67	2.90	2.90	2.86	2.89	2.50	2.77
b/b$_o$	0.700	0.685	0.704	0.627	0.634	0.685	0.674
Voids in coarse aggregate (dry rodded)	34.00	36.70	41.00	41.50	35.50	34.00	35.00
Cylinder strengths from test, lbs. per sq. in.	5,166	4,643	4,655	5,111	5,539	6,124	5,579
Cylinder variation factor, per cent	5.34	4.51	4.55	4.23	4.35	3.54	4.24
SIEVE ANALYSIS							
Per Cent Retained on—							
2½ inch	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1⅞ inch	5.8	7.3	6.0	1.7	2.4	0.4	7.3
1¼ inch	28.0	32.4	34.2	32.5	33.9	8.1	35.6
15/16 inch	15.9	19.7	18.5	20.4	17.1	13.1	17.4
⅝ inch	18.7	18.0	19.3	20.8	17.9	25.6	17.0
7/16 inch	14.9	9.4	11.1	12.3	12.4	24.7	10.9
¼ inch	16.6	13.2	10.9	12.3	16.3	28.1	11.8
VARIATION FACTOR FOR GRADING OF COARSE AGGREGATES							
1¼ inch	11.5	10.0	9.7	10.3	10.3	....	13.6
15/16 inch	....	....	....	....	....	15.9	....
⅝ inch	7.3	8.3	7.8	6.6	7.3	5.7	10.5
¼ inch	6.9	7.5	7.6	10.7	9.8	5.4	15.0
Average	8.6	8.6	8.4	9.2	9.1	9.0	13.0
GRADATION							
Per Cent Retained on—							
1¼ inch	33.9	39.7	40.2	34.2	36.3	....	42.9
15/16 inch	....	....	....	....	....	21.6	....
⅝ inch	34.6	37.7	37.8	41.2	35.0	25.6	34.4
¼ inch	31.5	22.6	22.0	24.6	28.7	52.8	22.7

of cement were used on the different jobs. In comparing the variation factor for a given job, we find the largest variation factors on the jobs where the multiple sizes of coarse aggregate were used, averaging 5.34 per cent, and the smallest variation where the single aggregate was used, averaging only 3.54 per cent. All these variation factors are relatively low, which shows very uniform strengths.

In computing the variation factor based on the sieve analysis, it appears that less variation of the gravel particles was obtained on the multiple-sized aggregate jobs, averaging about 8.5 per cent, with the single aggregate jobs averaging 9.2, 9.1, 9.0 and 13.0 per cent, respectively. These data indicated that better gradation control is obtained by using the multiple sizes.

All jobs were computed for the variation factor from the sieve analysis on the basis of grouping the separations of 1¼, ⅝ and ¼ sizes, except the Winona County job, which was computed on the basis of grouping the separations into 15/16, ⅝ and ¼, because only 8.5 per cent of the material was retained on the 1¼ in. sieve and the data could be better compared by using the 15/16 in. mesh instead of the 1¼ in. mesh. It was found on this job, as has been found on other jobs, that the amount of water required per cubic yard of concrete varies somewhat directly with the percentage of sand for a given coarse aggregate. The percentage of sand by weight as used for all the gravel jobs is as follows: 30.12, 34.69, 30.54 and 31.92, respectively. The amount of water used per cubic yard of concrete was 30.9, 32.7, 30.8 and 31.7 gal., respectively. The percentage of sand used for the limestone jobs is as follows: 33.04, 33.62 and 36.44. The amount of water used per cubic yard of concrete was 32.3, 35 and 37.6 gal., respectively. (See Table I for all these data.)

On the multiple-sized aggregate jobs it was found that the variation factor, as computed for the ¼ in. size range was less when the multiple sizes were used, except on the Winona job where 52.8 per cent of the material was retained by the ¼ in. mesh and passed by the ⅝ in. mesh. The multiple sized aggregates resulted in more uniform appearance of the batches in regard to consistency than the jobs where the single aggregates were used. That the consistency of the concrete was more uniform on the jobs using multiple-sized aggregates can be attributed to the fact that the material retained on the ¼ in. mesh sieve was more uniform on these jobs.

Small Sizes of Aggregate Should Be Kept Constant.—From the analysis of the materials it follows that it is the small sizes of the coarse aggregate that have the greatest effect on the consistency of the concrete, and it is therefore this aggregate that should be kept constant. This can be accomplished by separating the coarse aggregate into two sizes. This separation should be made nearer the small size of the aggregate.

It is believed that these variations shown by the tests represent actual variations that may likely occur in the slab. They indicate that there are variations in the ingredients of gravel, sand, cement and water, which occur from batch to batch due to batch operations, as well as other variations caused by the fact that no matter how long the concrete is mixed in the paver, the particles of gravel, sand, cement and water will not place themselves in their proper place.

In addition to these variations, a certain amount of segregation takes place while discharging the batch into the spreader-bucket and while discharging the concrete from the spreader-bucket onto the subgrade. Furthermore, even the best concrete puddlers do not have the time nor the ability to "weld" the successive batches together, nor to eliminate feather-edged batches. Finally, the front edge of the batch is often filled with the excess mortar that accumulates in front of the finishing machine. Therefore, if one cause of variation is eliminated, others still remain which may possibly serve to undo or cancel the value of the one eliminated.

When the three sizes of coarse aggregate are used, two 2-compartment bins are necessary. This usually requires an additional crane and a larger plant site. The time required for the trucks to load and pass through the yard is also increased. Stop-watch studies show that the extra time the 2-batch trucks had to spend at the loading plant on the Redwood-Renville county job amounted to approximately 1½ minutes. Because of this increased time constant an extra truck had to be used to prevent delays at the mixer.

Due to the fact that an extra crane, an additional truck, and two bins instead of one were required, and that the number of men at the aggregate plant had to be approximately doubled, the three sizes of coarse aggregate increased the cost per square yard approximately 3 cts. when the tandem mixers were operating at an average production of 62.6 batches per hour, or approximately 343.5 sq. yd. per hour. If a single paver had been used, the cost would have been increased approximately 4.4 ct. per square yard. Had the the materials been produced locally, the cost of handling would have been less because one crane could have handled the loading. The cost would then have been approximately 2.14 ct. per square yard if one paver was employed.

The method of loading out cars at the average aggregate plant causes segregation of the coarse aggregate. If the loading of the cars could be more carefully controlled, the amount of segregation could no doubt be reduced. It would seem that by exercising not only more care in the loading of the cars at the aggregate plant, but also in unloading the cars and in stock-piling as well, the variations in the gradation of the coarse aggregate could be materially reduced.

Some highway engineers contend that by the use of three sizes of coarse aggregate the proportion of the sizes can be so adjusted by batching at the stock-pile as to keep the percentage of voids at a minimum. It is believed, however, that almost equal results could be secured by proper control at the aggregate plant and at considerably less cost.

Summary of Time Losses.—Table II is the summary of the time losses obtained from the production studies made on Minnesota State-aid project 14-24 in Redwood and Renville Counties, where the multiple sizes of coarse aggregate were studied. There are shown losses due to lack of materials at the plant, to the operation of the batcher plant, and to switching at the plant; but these losses can not definitely be said to be due to the use of the multiple sizes. When the coarse aggregate is separated into two sizes instead of three, the cost of handling the aggregate at the batching plant will remain practically the same as when using one size of aggregate, provided room is available for the additional stock-pile and a 3-compartment bin is used.

A cost distribution chart prepared from the production study conducted on Minnesota State-aid project 14-24 where the tandem pavers were used, shows that the cost of the materials at the plant comprised 32.90 per cent of the total while the freight on the materials —coarse aggregate, sand and cement—comprised 30.65

per cent of the total cost. The cement cost 15.85 per cent, the coarse aggregate 14.08 per cent and the sand 2.97 per cent.

The equipment cost was 11.23 per cent while the labor, including that for hauling, was 10.74 per cent. Labor exclusive of hauling was 9.28 per cent.

TABLE II—SUMMARY OF TIME LOSSES ON MINNESOTA STATE-AID PROJECT 14-24, 1-2-3-4, REDWOOD AND RENVILLE COUNTIES

TOTAL MAJOR DELAYS OCCURRING DURING AVAILABLE WORKING HOURS

Character	Class A Hours	Class A %	Class B Hours	Class B %	Total Hours	Total %
Moving during job	86.92	10.01	.....	.....	.....	...
48-hour week.....	84.84	9.77	.....	.....	.....	.....
Wet grade	27.84	3.21	.....	.....	.....	.....
Rain	20.09	2.31	.....	.....	.....	.....
Holidays (Sundays not included)....	22.00	2.53	.....	.....	.....	.....
Breaking camp ...	15.34	1.77	.....	.....	.....	.....
Weather (cold, windy)	14.17	1.63	.....	.....	.....	.....
Lack of materials at plant.....	10.66	1.23	0.25	0.03	.....	.....
Subgrade	9.25	1.06	.....	.....	.....	.....
Water supply.....	5.50	0.63	8.33	0.96	.....	.....
Late start or quit early	2.98	0.34	0.33	0.04	.....	.....
Bridge crossing or approach	1.99	0.23	.....	.....	.....	.....
Water, valve, mixer	0.65	0.07	1.92	0.22	.....	.....
Mixer, mechanical.	1.25	0.14	.....	.....	.....	.....
Batcher plant.....	0.30	0.03	0.95	0.11	.....	.....
Miscellaneous	3.80	0.43	1.36	0.15	.....	.....
Totals 307.58		35.39	13.14	1.51	320.72	36.
Time paver actually operated.....					548.53	63.
Total available working hours.....					869.25	100.

Total actual production—34,344 batches or 188,602 sq. yds.

TOTAL MINOR DELAYS OCCURRING DURING TIME PAVER ACTUALLY OPERATED

Character	Class A Hours	Class A %	Class B Hours	Class B %	Total Hours	Total %
Hauling equipment, supply....	1.31	0.24	11.75	2.14	.....	.....
Hauling equipment, operation..	0.95	0.17	16.05	2.92	.....	.....
Paver operation...	.....	.....	12.16	2.22	.....	.....
Water supply.....	2.77	0.51	16.43	3.00	.....	.....
Dumping trucks...	2.08	0.38	4.50	0.82	.....	.....
Subgrade	0.45	0.08	2.00	0.37	.....	.....
Joints and steel...	3.95	0.72	1.89	0.34	.....	.....
Recharging paver No. 2.....	0.41	0.07	1.49	0.27	.....	.....
Double batches....	0.05	0.01	0.81	0.15	.....	.....
Crane or batcher operation	.....	.....	0.83	0.15	.....	.....
Switching in yard.	1.80	0.33	0.78	0.14	.....	.....
Mixer, mechanical.	2.80	0.51	0.66	0.12	.....	.....
Cleaning paver....	2.10	0.38	0.13	0.02	.....	.....
Miscellaneous	4.72	0.87	3.16	0.58	.....	.....
Totals	23.40	4.27	72.64	13.24	96.04	17.5
Time paver operated at 100% efficiency, hours					452.49	82.4
Total of all Class B delays, hours.....					85.78	.....
Total of all Class A delays, hours.....					330.98	.....
Overall efficiency, 84%.						
Possible operating time at 100% efficiency, hours.....						538.27
No. batches per hour's actual paver operation.....						62.5
At 100% efficiency						76.0
No. sq. yds. per hour's actual paver operation.....						344.0
At 100% efficiency.....						417.5

The major and minor delays amounted to 4.39 per cent of the cost. The minor avoidable delays absorbed the largest percentage of the cost. If the avoidable delays had been eliminated by better management, the saving made would have paid for the sand used on the job. The avoidable minor delays amounted to 17.47 per cent of the labor cost.

$120,000,000 Allotted to States

The appropriation of $120,000,000 in the Emergency Relief and Construction Act of 1932, for expenditure in emergency construction on the federal aid highway system was apportioned on July 23 by the Secretary of the Department of Agriculture. In the certificate of apportionment the secretary stated:

First. That the sums apportioned shall be available as a temporary advance of funds to meet the provisions of the Federal Highway Act as to State funds required on Federal-Aid projects and shall be limited in amount to the sum paid out by each State for work performed on the Federal-Aid highway system before July 1, 1933.

Second. That the amounts so advanced shall be reimbursed to the Federal Government over a period of ten years, commencing with the fiscal year 1938, by making annual deductions from the regular apportionments made under future authorizations for carrying out the provisions of the Federal Highway Act, as amended and supplemented.

Third. That all contracts let for constructing projects with the funds apportioned shall contain provisions establishing minimum rates of wages, to be predetermined by the State highway departments, which contractors shall pay to skilled and unskilled labor, which rates shall be stated in the invitation for bids and in the bids submitted for the work; that no convict labor shall be directly employed on any such project; that (except in executive, administrative and supervisory positions) so far as practicable, no individual employed on any such project shall be permitted to work more than 30 hours in any one week, and that in the employment of labor in connection with any such project, preference shall be given, where they are qualified, to ex-service men with dependents.

Fourth. That the specifications for projects to be constructed with the funds apportioned shall contain provisions, either approved or prepared by the Department, designed to provide the maximum employment of local labor consistent with reasonable economy of construction.

The allotment to the various states was as follows:

State	Sum Apportioned	State	Sum Apportioned
Alabama	$2,558,229	New Hampshire...	$ 600,000
Arizona	1,760,771	New Jersey.....	1,657,733
Arkansas	2,101,182	New Mexico.....	1,965,473
California	4,667,188	New York.....	6,059,238
Colorado	2,258,613	North Carolina...	2,888,251
Connecticut	778,806	North Dakota.....	1,933,901
Delaware	600,000	Ohio	4,490,175
Florida	1,624,752	Oklahoma	2,888,723
Georgia	3,123,298	Oregon	2,001,740
Idaho	1,505,912	Pennsylvania	5,267,060
Illinois	5,082,847	Rhode Island.....	600,000
Indiana	3,058,980	South Carolina...	1,666,755
Iowa	3,171,504	South Dakota.....	2,004,573
Kansas	3,265,048	Tennessee	2,605,160
Kentucky	2,264,637	Texas	7,664,621
Louisiana	1,745,559	Utah	1,395,331
Maine	1,067,079	Vermont	600,000
Maryland	1,019,570	Virginia	2,256,178
Massachusetts	1,716,612	Washington	1,920,470
Michigan	3,779,706	West Virginia.....	1,323,912
Minnesota	3,368,559	Wisconsin	2,991,076
Mississippi	2,160,164	Wyoming	1,541,561
Missouri	3,753,453	Hawaii	600,000
Montana	2,525,071		
Nebraska	2,544,773	Total	$120,000,000
Nevada	1,575,756		

A 14-Mile Traffic Signal System

The Hudson County Boulevard in New Jersey, passing through the municipalities of Bayonne, Jersey City, Union City, West New York and North Bergen, now has a traffic signal system extending over a length of 14 miles. It is one of the longest traffic signal system installations in mileage covered, the equipment including 200 General Electric adjustable signals, 82 composite traffic control boxes, 76 time switches, and 200 Union Metal poles, as well as cable, meter housings and incidental apparatus.

Appalachian Scenic Highway—Waterbound Macadam Road in White County, Georgia

The Road Across the Hills

From "New Mexico"

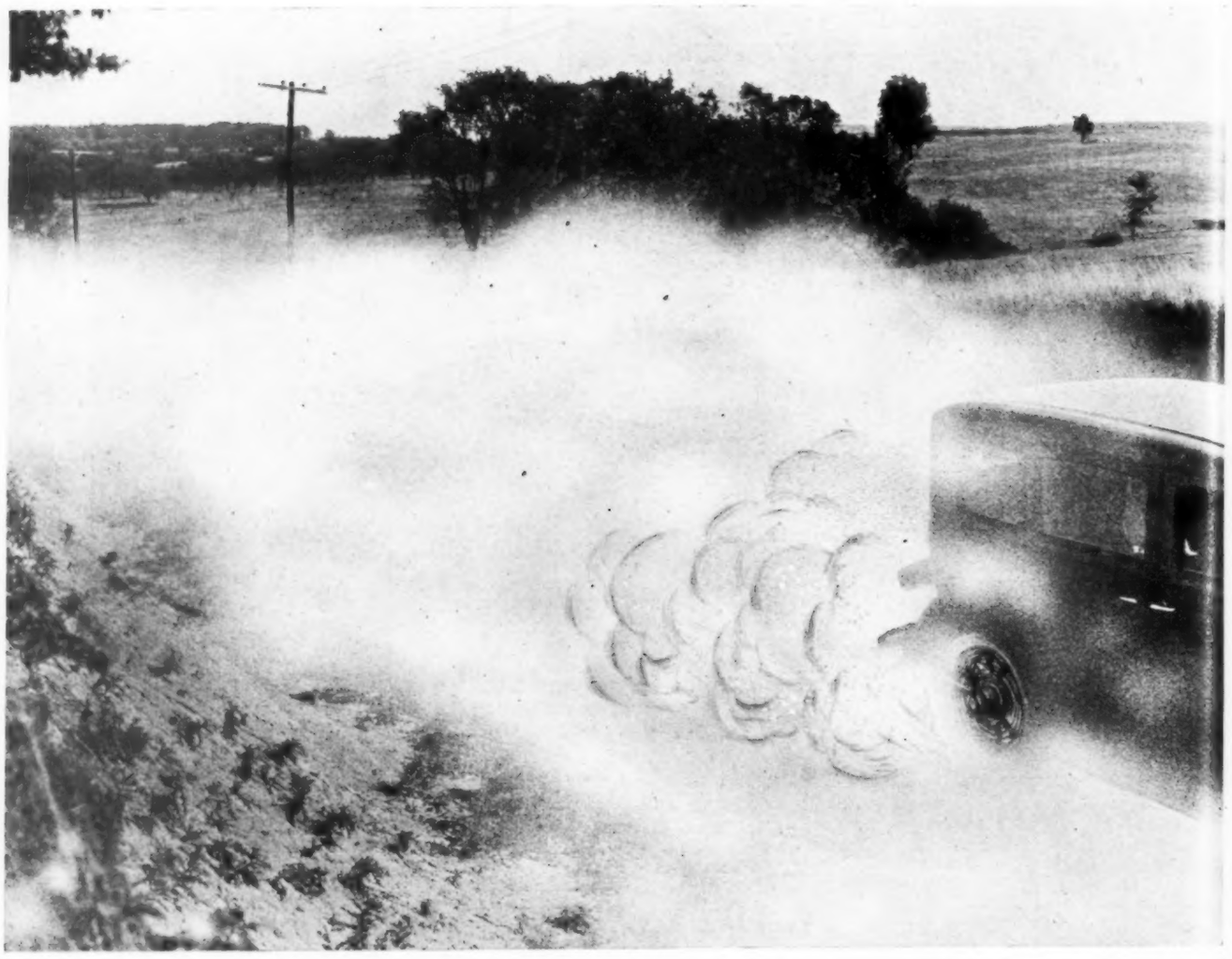
By LADD HAYSTEAD

When a doctor was needed the very worst way
It was forty miles of gumbo and clay—
Forty miles in the lowest gear.
When the crops were ripe and the grain all cut
A large per cent was never shipped; but
All of that was another year.

When the rains came down with morbid crash,
Or red tongues of flame licked the forest slash—
That was a road of fear;
With bog holes and ruts, hairpin curves and hills,
No bridges or spillways, no cuts, no fills;
But that was another year.

Grumbles and groans change to content and smiles,
That fearsome forty now a fast twenty miles—
Twenty miles of cheer;
A silvered ribbon that links to town—
No magic this—just hard work laid down
By the silent Highway Engineer.

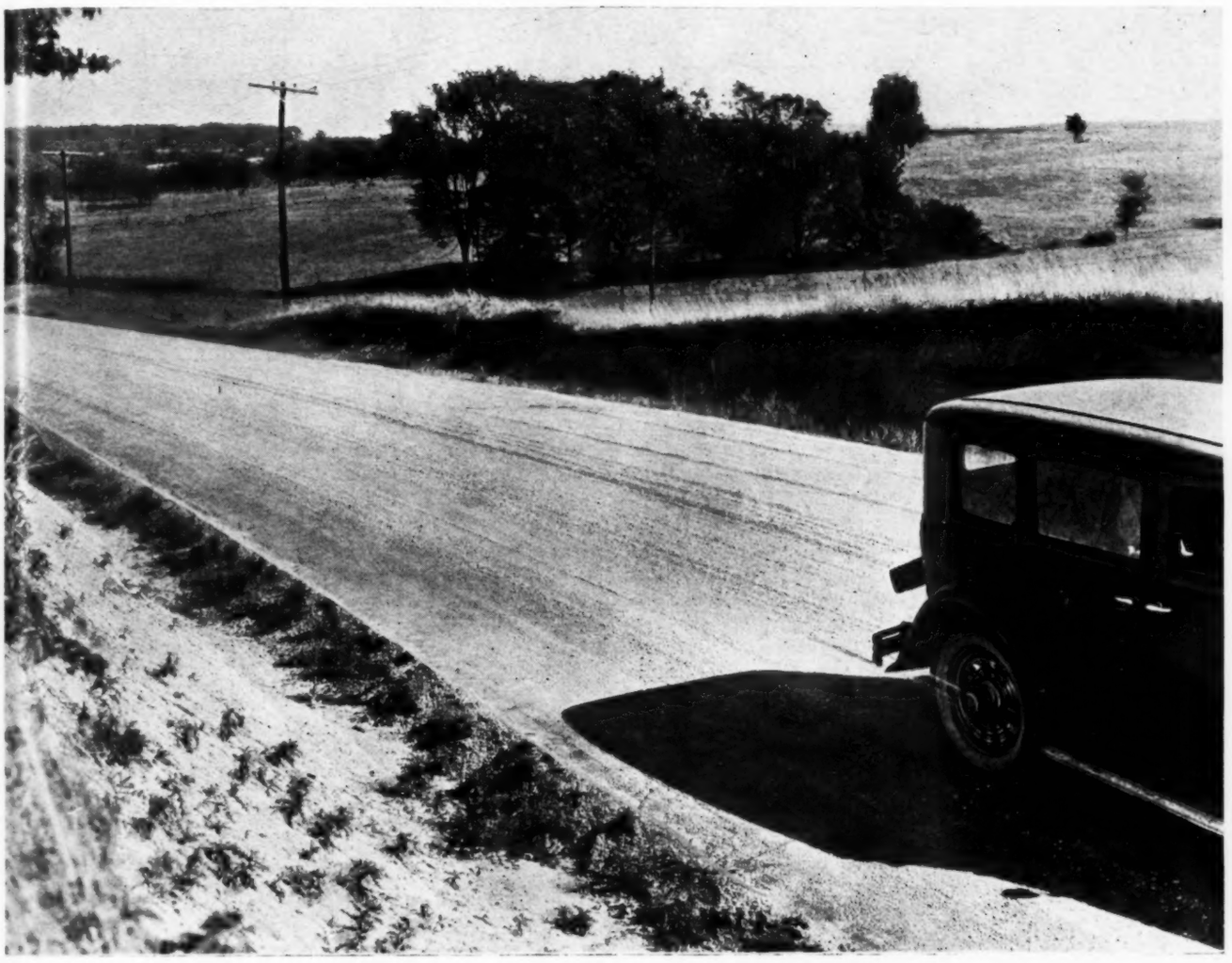
BEFORE



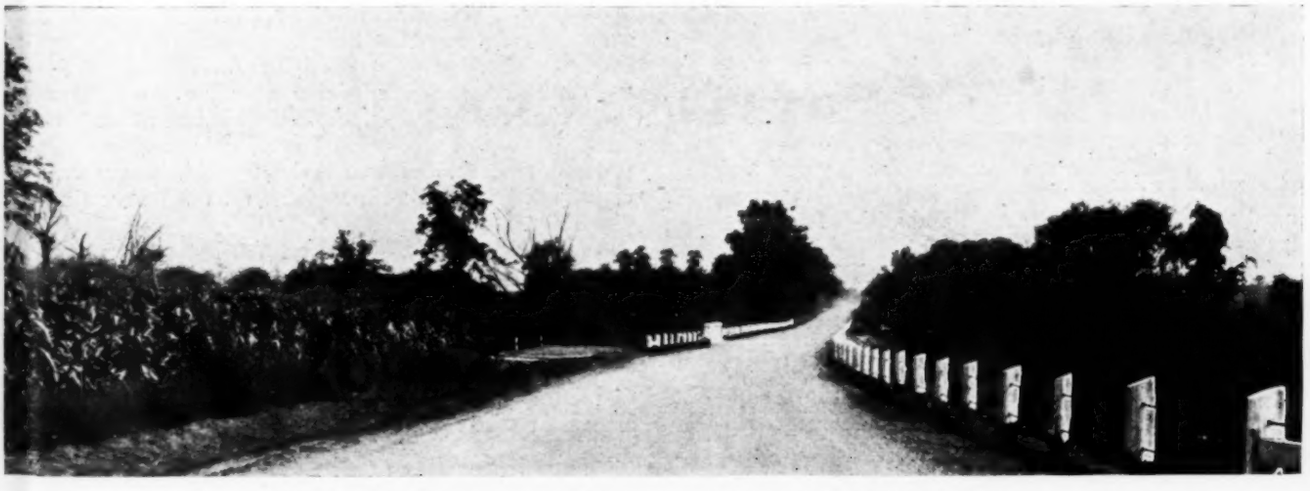
WE ARE all familiar with this road condition on some of our untreated earth and gravel roads. Driving on these roads is anything but a pleasure. Besides the inconvenience of driving, roads in such condition lose about an inch of surfacing annually.

An Old Bridge on an Angle of the George School House Road in Monmouth County, N. J.,

AFTER



THERE ARE different ways of preventing the dust nuisance on gravel and earth roads, thus eliminating not only the inconvenience of eating dirt but also the danger of accidental collision. In the case of this road, calcium chloride keeps the dust settled and helps keep the surfacing intact.



Was Replaced by a Concrete Slab Structure When the Road Was Graveled.

Low Cost Bituminous Surfaces In Vermont

By H. E. Sargent
Commissioner Vermont Department of Highways

LET us first consider the construction and maintenance of our bituminous treated gravel roads. The first essentials are proper drainage and adequate foundation. There is little inherent resistance to deflection in any type of bituminous treated gravel or thin broken stone surface. Such a surface will retain its shape just so long as it is unyieldingly supported by the foundation on which it rests.

Having then provided adequate drainage and sub-base, the next step in construction is the shaping of this sub-base to a true and even cross-section and grade. Most of our roads are built according to a profile and alignment laid out from a plan. We built one secondary road except for two relocations without the aid of survey or plans. Gravel was added to the old surface to true up the irregularities and add strength where needed. It was intermittently smoothed by a drag or grader and compacted by traffic until a true unyielding cross-section was obtained. Even though a sub-base is built to established grades, constant vigilance must be used to see that there are no irregularities between the 50 ft. stakes, and the drag or grader should be used daily. When building a new sub-base a 10-ton or heavier roller should be used if available to accelerate the compaction. To construct a smooth riding road, the best results will be obtained by having the same operator with the same equipment shape both subgrade and surface. The subgrade should be as true as the surface. A prime coat of tar, ¼-⅓ gal. per sq. yd., is then immediately applied and allowed to penetrate. This should be done at least a week in advance of the surface operations.

The gravel surfacing is then carefully spread to a uniform depth, and the bituminous material is applied and mixed with the gravel. By building a mixed-in-place gravel surface we construct at once a uniform thickness of surface that by the old methods of surface treatment was almost impossible to obtain except by years of treatment. Furthermore, by mixing we obtain a greater thickness of road surface than is obtained by penetration with the same amount of tar. Our experience to date has led us to prefer the use of tar with gravel and asphalt with broken stone.

While some gravel has been used as it came from the bank without even screening, better results are obtained by separating the sand from the stone and recombining in definite proportions on the road. The more closely the gravel meets the requirements for Class A concrete, the better mixed-in-place road it makes. A reasonably hard stone, cleanliness of sand and a high fineness modulus are essential.

Tar of 20 to 30 viscosity is used. A 2½ in. depth of gravel stone, maximum size 1¾ in. is spread. Tar is applied at ¾ gal. per square yard. Thirty per cent of sand is added and mixing begins. For this purpose we have developed a wooden drag 20 ft. long with steel blades in zig-zag arrangement. At the conclusion of the mixing it is advisable to use a grader to smooth the occasional ridges that the drag is likely to leave when such a depth of material is mixed. The surface is then given a limited preliminary rolling immediately. The sand is postponed if possible until the end of the job when ¼ gal. of tar is applied and covered with gravel and sand up to ¾ in. maximum size. This is smoothed with a drag of woven wire and rolled.

In the retreatment of our old bituminous treated gravel roads the use of a zig-zag drag has produced a wonderful improvement in the riding quality of these roads. It has also reduced the cost of maintenance by making the surface more durable.

Broken Stone Bituminous Surfaces.—Broken stone bituminous surfaces are mixed and smoothed by the use of a power grader with a wheelbase of about 18 ft. The maximum size of stone is nearly the depth of surface desired, which is either 2 or 3 in. The stone is spread by spreader boxes and the cut-back asphalt applied in two applications. After each application the stone is mixed by windrowing. Following the second mixing it is spread smooth and immediately given a limited preliminary rolling. A out-back asphalt with a viscosity Engler 50° C. of 150 to 175 and a penertation of the residue of 90 to 100 has proved most satisfactory. For a 2 in. surface a total of 0.85 gal. per square yard is required in the mix.

Use of Penetration Emulsion.—We have also built some low cost broken stone surface using a penetration emulsion. The stone was spread by spreader boxes and smoothed by a grader. The asphalt was applied in three applications successively keyed with chips and rolled. On the final covering the chips were smoothed with a drag. A light paint coat will then hold the chips in place giving the smoothness of a dragged surface.

The seal coat we have developed for our mixed-in-place broken stone roads has also been used on our hot penetration roads. We have found that it may likewise be used to make smooth our old macadam roads and thereby add years of useful life to them.

In the construction of this seal a prime coat of cut-back asphalt is applied to the surface at the rate of 1/5 to ¼ gal. per square yard. A layer of chips ¾ in. deep is spread immediately over the prime coat. The chips are then covered with another application of ¼ gal. per square yard. They are then mixed and smoothed by the drag and immediately rolled in place. The blades of the drag are set ¼ in. higher than the shoes. By this method all the irregularities in the surface are filled with coated chips. There is no loss of chips and the surface remains smooth, uniform and non-skid, because all the chips, being coated with asphalt, remain where they are placed.

We used this type of seal on two hot penetration jobs this year, but with a larger stone, from ½ in. to 1 in., which of course required more asphalt. A retread mixer was used instead of the drag. The result was an excellent non-skid surface texture.

This seal was applied with good results on an old macadam surface. We expect to smooth several old macadam roads with it next year.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 1932 meeting of the Association of Highway Officials of the North Atlantic States.

Replacement of Cuts and Openings In Concrete Pavement

By F. D. WOODRUFF
Assistant Superintendent of Maintenance, New Jersey State Highway Department

CONSTRUCTION of the modern heavy traffic highway involves the expenditure of a large proportion of the public funds. The returns from all well-placed public investments, direct or indirect, cannot be readily computed. We must, however, agree that investments in durable roads are sound economically, regardless of the manner in which the economics are applied. The military, industrial, commercial, educational, and recreational value of the modern highway is, without doubt, almost beyond our calculations.

These large investments in highway construction must be properly protected. This protection is secured only through intensive and direct maintenance; and maintenance includes not only routine care, but must also provide control over the restoration of utility openings and repairs to unforeseen failures in existing high type pavements. Principal among these pavements to be maintained are those composed of portland cement concrete.

Repairs of portland cement concrete pavements on our modern through highway requires a working control, not only of the methods to be employed, but also of the various aggregates, water content, and admixtures, if used, as well. Because of the many unusual factors involved, no specific laboratory supervision can be expected. Traffic conditions, time element, unskilled workmen, and other unavoidable conditions make it essential that a few simple rules be fixed in order that the very earliest high strength be obtained in the repair of these pavements. It is the rule that newly constructed concrete pavement must be cured for a considerable period before such pavements are subjected to heavy traffic. It is quite evident that it would be extremely disadvantageous to close any modern heavy traffic highway for a comparatively long period for the purpose of curing the restoration of a utility opening or repairs to miscellaneous failures.

The necessity of maintaining expensive and in many cases dangerous detours, and the disturbance to through traffic, may be almost completely eliminated by the development of high early strength methods. Higher strengths at twenty-eight days mean corresponding higher strengths at the shorter time period. The curing time, when proper control is exerted, can be reduced to eighteen or twenty-four hours, and even under strikingly adverse conditions to not in excess of seventy-two hours, atmospheric and temperature elements being given due consideration. Where patches are to be opened to traffic in eighteen hours, conditions must be almost ideal, workmanship must be of the best and accelerating admixtures must be employed generally.

Surprising results may be obtained by adhering to the following general fundamentals:

Cement.—The use of special cements other than true portland cements is not recommended. Special cements undoubtedly have merit where conditions warrant the expense and technical control, but special cements requiring unusual curing methods and treatment are not readily adaptable to average working conditions. Finely ground and specially burned portland cements requiring no treatment other than that given ordinary cement may be used, but in such cases no admixtures should be employed for additional acceleration. These cements are not always obtainable upon short notice and it follows that the standard commercial brands are the portland cements which will be available for emergency repairs required for utility openings and general surface failures.

Water.—The varying acid or alkaline conditions characterizing the average available water, which factors affect the ultimate strength of the resulting concrete, will not be determinable for usual cases in the field. Care should be exercised in order that water showing strikingly undesirable characteristics is not used. All other conditions being as nearly perfect as possible, the use of inferior water will as a rule produce poor results. This fact under no circumstances should be ignored.

Sand.—Sand, the fine aggregate, should be well graded in size, washed clean and completely free from all foreign material. Excessively fine material therein will usually require the use of additional water to produce a workable mix and in all probability will result in an inferior quality concrete. "Concrete sands," as found in New Jersey, generally have the essential characteristics, although some adjustment of the sand-cement ration may be required in actual work, in order to obtain minimum "slump," that is, proper consistency. The control of this adjustment may be very casual, dependent upon the ability of the workmen to recognize a sufficiently "dry" mix.

Stone or Gravel.—Stone or gravel, the coarse aggregate, is usually produced in satisfactory sizes varying from one-half inch to the so-called concrete sizes. As in sand, no loam, vegetable matter or decomposed fragments should be present. The size of the coarse aggregate to be employed will depend upon the character and extent of the repair section being treated. Small size coarse aggregates will develop better workmanship in small patches, as indicated herein, while the standard larger graded aggregates are suitable for larger areas.

Proportions.—Assuming that the determination of the void content of the coarse aggregate may not be made in emergency repairs, it will be found that an arbitrary mixture should be decided upon for average conditions. For general work this proportion should range between one part cement, one and one-half parts sand and two parts coarse aggregate (1:1½:2), and one part cement, one and three quarters parts fine aggregate and three and one-half parts concrete gravel or stone (1:1¾:3½), the former mix being used for patches averaging two square yards or less, wherein a "three-quarter inch" coarse aggregate is preferable and the latter for patches exceeding three square yards, in which the larger aggregate should be used. It is obvious that the smaller the repair section the greater is the effect of impact load insofar as bond may be considered. Where a comparatively large repair area is involved, these impact bond stresses are not exerted so quickly as on the small bond perimeter because of the gradual rolling load, but where the lesser areas are affected the load is immediately transferred to a relatively small area. It follows that the smaller repair section should receive more attention and in consequence richer and closer bonding mixtures should

be used. Whatever mixture may be determined upon, it is essential to slightly increase the cement ratio in the composition of the repair section. This increase may be fixed at 10 per cent, although during summer temperatures where admixtures are used, flash set should be closely guarded against. Where the original composition of the pavement being repaired is known, the same mixture may be used in large repair sections, although where some of our older pavements are encountered no absolute rule can be fixed.

Utility Trenches.—Not less than six inches of the concrete pavement should be removed beyond the edge of the utility trench. The subgrade so exposed, if of the proper stability, should not, in any manner, be adjusted. No foreign materials should be added to the subgrade, except where it becomes necessary to remove unstable material for a depth in excess of six inches. Where doubt exists as to the quality of the underlying foundation, the normal surface of the subgrade adjacent to the trench should be reduced for a sufficient depth to secure a substantial support which otherwise might be disturbed by the removal of the surface pavement to be repaired.

The backfill placed in the excavated trench, of course, must be thoroughly compacted, either by flooding or mechanical tamping. Wherever possible, this flooding or tamping treatment of the trench backfill should be carried out in layers not to exceed four inches.

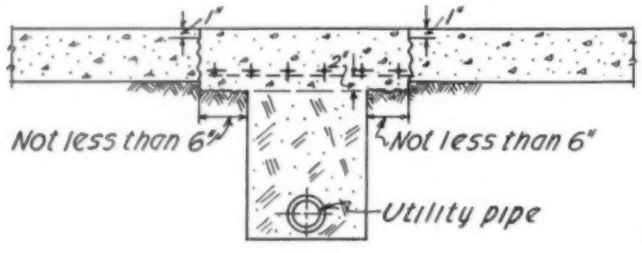


Fig. 1

Surface failures.—Surface failures as a rule result from the use of inferior materials, poor workmanship, improper subgrade contraction, or bad drainage. The repair section should be of such quality as to correct the inferior workmanship and material factors, while a simple inspection should determine the necessity of auxiliary lateral drains to overcome any objectionable water levels. Where failures have occurred because of insufficiently compressed subgrade, it is essential to remove all material underlying the pavement which may give any indication of instability. Where the removal of the subgrade for a depth exceeding six inches becomes necessary, a thoroughly compacted sub-base of broken stone or other suitable material should be substituted. To overcome the possibility of such instability extending beyond the limits of the repair section, the subgrade under and adjacent to the section to be patched should be removed as far as possible. While this treatment may not be as effective as the removal of additional surface area, it has been found that radiating progressive failures have been almost completely overcome by this procedure.

Preparation of Repair Edges.—No edges, uniformly plumbed and tooled for the total depth of the pavement, should be permitted where either utility opening or surface failure repairs are to be made. The upper section of the adjacent concrete, however, should be plumbed for a depth not to exceed one inch to secure a firm shoulder. An edge smoothly plumbed for the total depth of the repair section is effective only where expansion and contraction features are to be considered

Fig. 2

such as in the case of individual slab construction. In some cases old surfaces have been found where oil film has penetrated to a considerable depth. No permanent bond can be expected where this condition prevails, although a rough abutting edge undoubtedly offsets this factor to some extent insofar as bond is involved. Where a permanent bond is required, the use of a perfectly plumbed edge only invites early failure of the union between the old and new pavement and the consequent "punching out" of the restoration. A rough uneven adjacent edge, properly treated, adds materially to the strength of the repair section and insures more effective bonding. Spalled or scaled surface areas of old concrete immediately abutting upon the area to be restored should not be plastered with portions of the mixture placed in the restoration. Such shallow repairs quickly chip out and thus leaving a non-uniform surface, subject the restored area to undesirable impact loads. To obviate this condition is may be necessary to remove sufficient additional old concrete to provide an even surface at the intersection of the old and new concrete.

Reinforcement.—Reinforcing steel, preferably three-eighths inch diameter deformed, should be placed in the restored section two inches above the bottom of the slab. The amount of such reinforcement to be used will depend upon the dimensions of the opening being repaired and upon the condition of the subgrade. In general the spacing of this reinforcement should conform to the spacing found in the old pavement both transversely and longitudinally. Where reinforced pavements are encountered, either in the repair of utility trenches or failures, the existing reinforcement in the area of the repair should not be removed, but should be bent out of range of repair operations until the section is to be replaced, at which time the steel should be returned as nearly as possible to its original position and tied in with new reinforcement. Where unreinforced pavements are encountered, a mat of bars not more than twelve inches center to center should be employed. Such reinforcement is of vital importance in restorations over service trenches. In case of extra depth patches, two lines of reinforcement as indicated in Fig. 3 may be used.

Method of Placing Concrete Mixture.—Treatment of Repair Edges.—The edges of the existing pavement, which have been faced vertically for a depth not to exceed one inch measured from the surface, should be thoroughly washed, wire brushed, wetted down and painted with a one to one mortar coating immediately previous to the placing of the concrete mixture. This treatment is quite essential at all times, but obviously

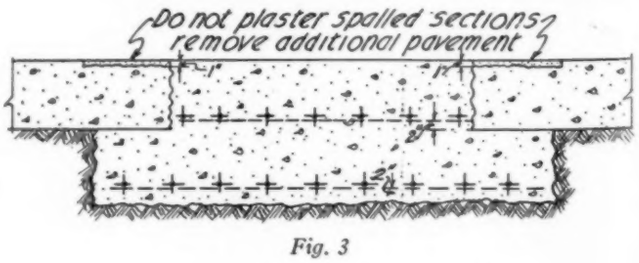


Fig. 3

more so with high summer temperatures, during which periods the edges must be completely cooled and saturated previous to the one to one mortar coating, to be followed immediately by the installation of the concrete mixture.

Concrete Mixture—Plain.—The water content of any plain mixture should not exceed four gallons per bag of cement. This water factor is further restricted by the moisture content of both fine and coarse aggregates. During certain periods of the working day a stock pile, whether it be fine or coarse aggregate, being used from the bottom may contain much more water than may be found in the top of the same pile. This condition, which is beyond any systematic control, must be carefully watched and the water added at the mixer drum adjusted accordingly. The aggregates, without admixture, should be mixed from not less than two and one-half minutes to five minutes in a machine mixer. No hand mixing methods should be employed. The resultant mixture should flow from a square pointed shovel with difficulty and should show no appreciable slump when dumped upon the subgrade. Any mixture showing more than a one-inch slump in twelve inches should not be used in high early strength repair work. The four gallon water-cement ratio mixture will, as a rule, produce a consistency which is called "unworkable." This "unworkable" mixture should be placed in the repair area in two-inch layers, each layer being thoroughly compacted by either manual or mechanical manipulation. The repair in layers should be complete before initial set takes place. The final "dry" layer of concrete having been placed must be tamped sufficiently to bring out a workable surface; the surface roughly planed and kept slightly above the finished grade. The final tamping and finishing of the surface should be done as late as possible in order that, practically speaking, the shrinkage of the concrete may be worked out prior to the time of setting up. The proper time for performing this final operation will vary under different conditions with different materials, but is best recognized by the surface drying up appearance of the concrete. At this point the surface should be tamped thoroughly, planed to grade and finished to proper surface. Unless the surface of the patch is re-tamped and finished at this later period, all bond may be lost. No proper bond can be expected unless the concrete mixture is reworked at this point at which time the final shrinkage is about to take place, neither can a suitable bond be expected unless the edges of the adjacent concrete are first cleaned, then washed, and given mortar treatment.

Using certain admixtures concrete repair sections may be thrown open to traffic in twenty-four hours or less:

Concrete Mixture—With an Admixture.—Calcium chloride* has been and may be used to advantage when necessary to secure high early strength rapidly under emergency conditions in low temperatures. Freezing weather and the construction of driveways to hospitals and fire houses and the repair of sections under super-traffic conditions make necessary the reduction of the freezing point and the rapidly increased acceleration of the final set. The fact that the use of calcium chloride only slightly reduces the freezing point must be considered. In low temperatures it is quite essential to heat not only the water, but the other aggregates as well. Neither should any concrete be placed upon a frozen subgrade. The results, which may be obtained through the use of calcium chloride as an admixture, in some cases do not give any great advantage over the proper use of plain portland cement, although the acceleration of the final set, which is undoubtedly more rapid, makes its use necessary in many instances. Whether calcium chloride has an important deteriorating effect upon steel reinforcing has not yet been definitely determined, but for all practical purposes this controversial point can be ignored.

A portland cement concrete mixer containing calcium chloride should contain no more water than that used in plain mixtures, but such mixtures must be manipulated much more quickly in relatively high temperatures than the plain cement combinations. Initial set takes place much earlier in high temperatures, and in consequence the depth of the layers to be tamped should be increased to not less than four inches. The same procedure of finishing as used for plain concrete mixtures should be followed just prior to the initial set, although at low temperatures there appears to be no difference between the action of a calcium chloride treated mixture and an untreated mixture in summer weather. The water and fine and coarse aggregates should be heated during freezing temperatures. This will insure more rapid hardening of the concrete. Where this procedure is followed temperature conditions must be given utmost consideration and the proportions of admixture, if used, must be carefully controlled. The mechanical mixing time should not exceed two and one-half minutes in summer temperatures. Where the mixing time is in excess of this period, the mixture may set up in the drum of the mixer, or before the final tamping of the repair section has been completed.

Proportions.—For rapid acceleration at temperatures above 70° Fahrenheit, a one and one-half per cent calcium chloride solution may be used. At temperatures between 50° and 70° Fahrenheit, a two per cent solution; 32° to 50° Fahrenheit, a two and one-half per cent solution; and at temperatures from 24° to 32° Fahrenheit a solution containing three per cent calcium chloride has been found satisfactory. No two portland cements will, however, react the same in combination with such an admixture, but for average working conditions these rules can be followed.

Preparation of Solution.—The admixture, if calcium chloride, should not be added to the mixer drum in a dry condition. It must be added in solution in order that a thorough distribution of the salts may be assured. If added in the dry state, isolated portions containing the admixture may occur, quickly setting up and not only fouling the mixer drum, but if placed in the repair section causing areas of unequal initial set. To prevent any unequal proportions, the solution should be prepared accurately before the admixture is placed in the mixer drum. If a two per cent solution is required, a fifty gallon capacity container filled with forty gallons of water should be employed. To this should be added one hundred pounds (100 lbs.) or 75 per cent calcium chloride and the mixture agitated until the calcium chloride is completely dissolved. Add sufficient water to bring the total solution to fifty gallons, at which point each gallon of solution will contain two pounds of calcium chloride. A gallon of solution added for each bag of cement will then produce what is known as a two per cent admixture, or two (2) pounds of calcium chlo-

*The term "Calcium Chloride" is used in a general way only. Any other admixture of equal proven effectiveness may be used provided its characteristic reaction to the cement aggregate, and reinforcement is not detrimental. Where calcium chloride is mentioned it is assumed that it shall conform to the following requirements:

$CaCl_2$ (Anhydrous)	not less than 75 per cent
$Mgcl_2$ (Anhydrous)	not less than 75 per cent
NaCl (Anhydrous)	not more than 1 per cent
Other Impurities	not more than 1 per cent

The proportions of solutions indicated herein are based upon 75 per cent pure anhydrous salts, the other impurities being disregarded.

ride for each bag of cement. This process may be adjusted to produce any concentration of admixture desired. The calcium chloride solution is not to be used in addition to the desired water ratio. If a total of four gallons of water is required, only three gallons of pure water may be added at the mixer drum in addition to the one gallon of calcium chloride solution.

Curing.—A concrete mixture containing calcium chloride, having been placed and finished to the proper surface, requires no careful curing, but during high temperatures the finished pavement should be protected by burlap saturated at frequent intervals. In plain mixtures the repair sections should be cured with wet hay or by the ponding method until the area is to be thrown open to traffic.

Conclusions.—The above described processes may be summed up briefly as follows:

Where high early strength concrete is essential, the water-cement ratio of the mixture should be given first consideration. There is no doubt but that the ultimate strength of the finished concrete depends chiefly upon the water-cement ratio and secondly upon the mixture and its manipulation. It follows then that sufficient water to secure only a mixture hard to work should be used. As a rule the water should not exceed four gallons per bag of cement inclusive of any admixture solution which may be decided upon, the moisture content of the fine and coarse aggregates being ignored. Use a rich mixture for small patches, preferably one, one and one-half, two (1:1½:2); for large patched use a leaner mixture, one, one and three-quarters, and three and one-half (1:1¾:3½). Having thoroughly cleaned, washed and grouted the edges of the old pavement, tamp the patch in two-inch layers when no admixture is used in high temperatures or where an admixture is used in low temperatures; in four-inch layers where an admixture is used in high temperatures and where in low temperatures, with an admixture, the aggregates are heated. Finish the restored section slightly higher than the old pavement before the initial set. At initial set retamp and plane the restored surface to the proper elevation. Cure the patch thoroughly in warm weather by moistened hay or burlap, although in medium temperatures with an admixture such as calcium chloride, no specific curing is essential. In freezing weather protect the concrete from frost, regardless of the use of an accelerating admixture or heated aggregates and water.

Colors.—It has been found that the color of the adjacent pavement may be matched in the repair section by the use of carefully adjusted mixtures and by the incorporations of ferrous oxide in the concrete. Such a process is, however, not recommended for emergency repairs, owing to the fact that a highly skilled personnel, not as a rule found in general work, must be used to obtain exactness. A high early strength concrete is the ultimate desire, regardless of the fact that a "crazy quilt" surface appearance may be objectionable to the traveling public. Extremely difficult methods of control will be found necessary to accomplish a blending of colors and it is felt that the early opening of concrete pavements is of far more importance to our vehicular traffic than the problematic results which might be obtained in an effort to please the eye. Where blending of colors is, however, considered necessary, pleasing results have been obtained by determining carefully the composition of the original pavement and incorporating in the patch cement, sand and coarse aggregate from exactly the same sources as applied in the old concrete. If the new patch is placed as outlined herewithin, there should be no shrinkage of the new concrete away from the old and consequently no reason to paint the perimeter of the repair section with bituminous material.

Acknowledgment.—A paper presented before the Eighth Annual Convention of the Highway Officials of the North Atlantic States.

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Minnesota Highway Commissioner Suggests Study of Patrol Report as Aid to Proper Driving

A highway bulletin summarizing the report of the state highway patrol for a month shows aid to have been rendered to individual motorists in Minnesot to the number of 33,121 and corrective action taken with regard to other motorists to an extent which prompts Commissioner C. M. Babcock to suggest the study of the report by the driving public as an aid to correct usage of the highways.

The primary aim of the state highway patrol is that of assisting motorists to reach their destinations with the fullest possible measure of ease and safety. The making of arrests is a last and not a first recourse, Commissioner Babcock states in drawing attention to the variety of irregularities upon the part of motorists indicated by the report.

Warnings were given to 1,676 motorists and because practically every type of the infractions for which the warnings were given could subject the motorist to arrest, the complete list is given as follows: Improper license, improper passing, improper parking, improper turn, improper lights, improper brakes, improper signaling, passing on curve, passing on crest of hill, cutout open, stickers on windshield, through stop-sign, one-arm driving, cutting in on traffic, over-weight trucks, not driving in correct lane, faulty steering gear, soliciting rides, venders on highway, defacing highway, speed in congested area, live stock on highway, size of load.

Tags requiring correction within 48 hours were given to 2,933 motorists on account of illegal equipment and other irregularities of 23 different kinds as follows: Illegal brakes, license swinging, license obscured, no windshield wiper, no warning device, no rear-vision mirror, exhaust not muffled, illegal tires, rear lamp not lighted, license not illuminated, one headlight out, glaring lights, insufficient light, lamps out of adjustment, illegal lamps, no clearance lamps, faulty steering gear, one license plate missing, no license plates, wrong license plates, not having Minnesoto license plates, no visitor's permit displayed, not having chauffeur's license.

While arrests were few, totaling only 114, the fines imposed on these amounted to $3,730. The violations for which arrests were made are classified as—driving while drunk, 37; improper use of licenses, 29; careless driving, 18; failure to stop for arterial highway, 26.

Patrolmen attended a total of 99 accidents during the month, and in a number of instances rendered first aid to injured persons.

Many of the motorists to whom the patrolmen found it necessary to give attention were from other states, and when it was felt that the purpose would be served as well their attention was but brought to the infraction of the law of which they were guilty; but, where the safety of others was at stake no greater consideration could be given them than others.

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Loan Wanted for Hudson River Tunnel—The port of New York authority has sounded out the board of directors of the Reconstruction Finance Corporation on the prospects of getting a $75,000,000 loan to build another vehicular toll tunnel under the Hudson river.

EDITORIALS

Socialistic Taxes

IN a recent article Calvin Coolidge advocates a general sales tax in place of the income tax, thus adding another important name to the rapidly growing list of opponents of the present disastrous system of federal taxation.

An economist writing in Saturday Evening Post has shown the ill effects of the British income tax, which he regards as being the main cause of the industrial decline of Great Britain since the close of the world war. He points out that capital has been steadily depleted by the income tax, resulting in reduced employment at reduced wages. This, in turn, has led to "the dole," the evil effect of which is admitted on all sides. The graduated income tax, which was hailed 15 years ago as the most equitable of taxes, has developed into a socialistic device for bringing the rich down to the level of the poor. In England it has gone a long, long way toward that goal. The more far-sighted students of political affairs, like Coolidge, see that what has happened in England bids fair to happen in America. Our congressmen, eager to show voters that they are opponents of the wealthy, easily persuade one another that corporations should pay one-seventh of their net earnings to the federal government and that individuals should pay in taxes one-third or more of their income if it is a large income.

The plain truth is that socialism is gradually forcing its principles upon Americans in the guise of graduated income taxes. First, the federal government adopted this pernicious system of taxation as "a war measure." The war ended 14 years ago, yet we have no letup in this "war measure." It is now called "a hard times measure." The states were urged not to pass income tax laws, on the ground that this particular way of plucking the golden goose should remain the prerogative of Uncle Sam. But several states have already adopted a graduated income tax, and others are on the verge of following their precedent.

During the hundred years that began in 1830 and ended in 1929, American wage earners enjoyed an average increase in "real wages" amounting to 400 per cent. In all the history of mankind, no such increase in economic welfare had occurred. This was accomplished under a system of government that was the freest from socialistic principles. The getting of wealth by individuals was encouraged and taxes were not designed to take away the wealth of those who were most successful in acquiring wealth. Due largely to the great size of our country, neither guilds nor labor unions were able long to suppress the introduction of labor saving devices.

Competition of capitalists for labor was usually keen because the prospect of liberal profits was usually excellent. Yet the census showed, decade after decade, that the average profit of manufacturers was only about 10 per cent. In less than five years real wage rates advanced more than that 10 per cent, on the average. Hence in effect all that the socialists promised, namely, a distribution of profits among the masses, was accomplished by the 10 per cent rise in real wages every five years.

This was our economic history during a century, nearly all of which was characterized by the greatest freedom from socialistic and unionistic control. In recent years, however, the European microbe of socialism has infected a large number of our legislators. New Zealand and Australia were thus infected about a generation ago, and are now so economically ill that our present temporary bad health looks to them like the best of health.

It takes less than 20 years of socialism to bring a nation to the verge of despair, whether that nation be one of the oldest or one of the youngest on earth, and even where its people are of our own blood. In England we see one of the oldest, and once the most prosperous of nations, reduced almost to penury. In New Zealand, we see an even worse condition among people of British stock, in a country abounding in natural resources and but sparsely settled. In both England and New Zealand we see the same basic cause of growing distress—socialism.

Let us not be deceived by names and catch phrases. Our politicians rarely call their measures socialistic. Certainly they didn't put that label on the income tax. Yet the catch phrase "taxation in proportion to ability to pay" really hides as socialistic a law as any country has ever adopted short of complete confiscation of property. There is no distinction in socialistic principle between confiscation of a wealthy Russian's entire property by a bolshevist government and the taking of one-third of a wealthy American's income by an American government.

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A Proposal to Limit Utility Corporation Indebtedness by Law

COMMENTING upon the receivership of the great Midwest Utilities Company a banker said to the editor: "If all public utility and railway company securities were like those issued by banks, this catastrophy would not have occurred. A bank can issue no bonds and it can issue no preferred stock. The consequence is that if it is honestly managed and if there are no runs on the bank, a receivership seldom occurrs. Most public utilities and railways have raised half their capital by bond issues. That creates a dangerous condition which may be financially fatal in times of great industrial depression."

The present depression has taught again the grave risk that almost every business corporation incurs when it borrows a large percentage of its capital. But it has probably not occurred to many business men that it may be wise to eliminate almost all borrowing, as suggested by this banker. He would reduce borrowing by utility companies to that required for current needs. He went on to say that under the Federal Reserve System many merchants have been led to issue bonds because their notes were not acceptable for rediscount when the notes exceeded current or liquid assets. Instead of advising the raising of capital by sale of stock, investment brokers have usually advised bond issues. Such bond issues, the banker explained, were more dangerous to the company than borrowing from banks; for bond buyers are usually not good judges of the extent to which a company may safely go in borrowing, whereas bankers usually are fairly good judges. However, he placed the

greatest emphasis upon the desirability of restricting the indebtedness of utility and railway corporations by law. "The abuse of credit is one of the main causes of depressions," he said.

Probably this abuse is much more fundamental than is the manipulations of the stock market by professional stock gamblers. But the country is so greatly aroused over recent revelations as to this sort of predatory enterprise, that protection is more apt to be secured against it in the near future than against the abuse of credit through excessive issues of bonds.

A third measure aimed to reduce the bad effects and shorten the duration of depressions seems likely to become a law in the near future. We refer to the guaranteeing of bank deposits.

With laws limiting the relative amount of borrowing by certain classes of corporations, prohibiting "pools" in the stock market, and guaranteeing bank deposits, there is high probability that America would never again witness a depression like that of the present, except possibly during a great war.

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When Scientific Ignorance Is a Blessing

HAD Marconi possessed Lord Rayleigh's knowledge of electromagnetism he would not have invented apparatus for sending wireless messages across the Atlantic. Rayleigh knew that Marconi's waves would be reflected from the earth's surface, and therefore he thought he knew that they could not travel past the spherical bulge in the earth between Ireland and Newfoundland. Not knowing as much as Rayleigh knew, Marconi built his apparatus and succeeded. His partial ignorance of physics was a blessing.

This paradox is readily explained when it is remembered that physicists were ignorant that the earth is encased by a shell of electrons that reflects radio waves. Hence they assumed that Marconi could not succeed. The principle of reflection of electromagnetic waves by an electric charge made Marconi's success possible, yet it was the very principle that Rayleigh cited against the realization of Marconi's dream.

Although this will always be one of the great examples showing that "a little knowledge is a dangerous thing," it will be many a year before scientists will really admit that their knowledge is little. They give lip-service to the generalization that scientific knowledge is small beside the unknown laws of Nature; but their true attitude toward their knowledge is better shown by the prevailing tendency to condemn almost every new theory that seems to conflict even in slight degree with so-called established principles.

The late Frank H. Bigelow, professor of meteorology, nearly 40 years ago advanced the hypothesis that the sun is a magnet and that its magnetism affects our weather. Faraday had previously suggested that terrestrial magnetism affects movements of the air. Balfour Stewart argued that high temperature destroys magnetism, hence the sun could not affect the earth magnetically. Bigelow replied that the earth's interior is very hot, yet the earth is a magnet. However, it was not till 20 years ago that Hale proved that the sun is a magnet. Even then Bigelow's hypothesis met with few advocates, because Hale's spectroscopic measurements indicated very weak solar magnetism. About the same time Marconi's success led to the discovery that the earth is encased in a shell of electrons, which must be magnetic because of axial rotation of the shell. However, this fact led no one to suggest that the sun may be encased in one or more electron-shells whose magnetic force may be great enough to displace or distort our electron-shell, and cause currents of electrons that may give important motions to our atmosphere. When this hypothesis was first advanced by the editor it met with no approval, not because it lacked plausibility but because it came into conflict with the established theory that heat connection currents rule our atmosphere.

It is interesting to consider how the sun may possess great magnetic power that is not discoverable by the spectroscope. Let the sun be encased by a rotating powerful electron-shell of vast diameter. Then at the center of that shell no magnetic effect would be measurable, because the magnetic forces would balance one another. The same would be true of the electric forces.

Newton proved that gravitative forces are perfectly balanced anywhere within a spherical shell of uniform thickness and density. A resident within such a shell would never be able to determine its mass; in fact, would never suspect that it had any mass.

Faraday charged a hollow shell with electricity and entered it with his galvanometer. The galvanometer showed not the slightest evidence that a strong electric charge was nearby. Our physicists have not realized that Nature has placed them perpetually inside the same sort of a charged shell that Faraday devised and entered. Nor have they considered the possibility that the sun and every planet may lie at the core of a series of concentric electro-shells. Let this be granted, and nearly all their objections to an electromagnetic theory of weather are met at one stroke. Then it becomes apparent that the laboratory instruments with which they measure electric and magnetic forces are of little or no use in testing an electromagnetic theory of weather, unless they use those instruments to measure the effects of currents of electrons caused by displacement or warping of the electron-shells that surround us.

Ever since Newton discovered the law of gravitation astronomers have assumed that all the important motions of the heavenly bodies can be explained by gravitation and inertia. But if each star is the core of a series of rotating electron-shells, the largest of which has a radius that is a considerable part of the distance to certain other stars, it may be that stellar motions are largely controlled by electromagnetic forces. "Star-streaming" and the geometric forms of certain constellations then become intelligible.

Gravitative force varies inversely as the square of the distance. For bar-magnets the pull varies inversely as the cube of the distance, where that distance is infinitely great compared with the length of the bar-magnet. For a current of electrons flowing through a long wire the magnetic pull varies inversely as the distance from the wire. Electron-shells of vast diameter approximate this last named condition with respect to external bodies relatively not far away.

A little knowledge of heavenly bodies may have been exceedingly dangerous in certain astronomical speculations, and some "ignorant" Marconi may "blunder upon" astronomical discoveries quite as amazing as were his in the realm of etherial waves.

H. P. Gillette

County and Township Roads

Gentlemen!

Close the Road—
Or Else Maintain It!

UPKEEP SAVES THE ROAD *INVESTMENT*

By C. N. CONNER
Engineer Executive, American Road Builders' Association, Washington, D. C.

According to the best available information, we built about two billion dollars' worth of highways from 1923 to 1930, and it seems reasonable to suppose that these roads are still in existence. This represents an enormous public investment which can be very seriously depreciated if the highway maintenance work is neglected. It is difficult to estimate, of course, just how much maintenance would be required since this will vary with climatic conditions, traffic, and the type of original construction, but we feel that this danger should be pointed out to those responsible for apportioning such cuts as may be necessary in highway expenditures, between the maintenance and construction.

In many cases the maintenance funds have been cut to an extent that they may jeopardize the public investment in highways.—*Editor.*

COUNTY officials all over the country are alarmed at the danger to the public and the losses of public property due to poor upkeep of our roads. These losses and dangers are the result of pressure brought to bear by taxpayers to reduce road expenditures.

Very shortly the public will again be traveling on dusty roads, full of holes, between forests of weeds growing on the roadsides that obscure the view to the great danger and discomfort of all travelers unless proper upkeep is continued.

Dollars invested in roads that are paying good dividents in safety, comfort and economy to the traveler will, under poor upkeep conditions, cease to produce dividends in anything but swear words, more gasoline and time consumed, and rapid depreciation of motor vehicles.

Proper and thorough upkeep of roads not only conserves the public investment in the improvement but it also provides safety, economy, and comfort for traffic. Maintenance saves dollars already invested in roads that without maintenance will be washed away by rains or blown away by the winds.

Road upkeep is practically all done by local labor, and it offers the best opportunity for the relief of unemployment. Men, teams, and trucks can all be used to advantage. There is no work that more readily absorbs men from all types of industry than road maintenance.

The economy of road upkeep and conditioning, its

speed of accomplishment, and its thoroughness have all been developed marvelously through modern machine methods. The low cost of maintenance with machines easily operated by local road workers makes the neglect of road upkeep a matter of almost criminal mismanagement. The future management of the roads is in the hands of the public.

What are county officials to do under the curtailment of road expense demanded by taxpayers? One thing is certain. The taxpayers themselves must suffer from the neglect of road maintenance. If the taxpayers do not want the county forces to maintain the roads, then they must do it themselves, and each one must get out of his car and fill the holes himself. That system of letting things go was tried in the '90s with the result that few improved roads were built, the roads that were improved soon went to rack and ruin, and a tremendous public clamor was raised against the condition of the highways.

Simple common sense will lead any thoughtful person to decide that no matter what the emergency the wastefulness of poor maintenance must be avoided.

Funds, of course, are only available for gradual improvement, but many miles of lower type road can be made to serve existing traffic by well directed maintenance.

The action of time and weather causes continual deterioration of the most soundly constructed roads and a standard of upkeep must be maintained in order to preserve the public investment. The high speed of traffic creates a constant hazard and requires unceasing vigilance so that obstructions to travel may be eliminated.

Any county has an enviable opportunity to render public service, and it should be the constant aim to carry on the work as economically as possible, but at the same time keep the roads open for the safe movement of traffic.

Money spent for upkeep gives quicker returns on the investment than any other expenditure made for road work. Accordingly, money properly and economically spent for maintenance meets with instant and popular approval from the traveling public.

It is of vital importance to every county that an efficiently organized department for the preservation of their roads be in continual operation. Not only does the convenience of the traveling public demand the upkeep and repair of the various projects comprising the road system, but from an economic standpoint the vast funds expended in road construction represent a capital investment whose physical properties must be continually repaired to reduce depreciation to a minimum.

It is just as important to maintain the roads as to repair leaks in the courthouse roof. We can perhaps do without expensive postoffices or city halls, but we must have roads.

Any saving in taxes which might come from reducing the road budget would be small compared with the extra cost of transportation which must result from poor maintenance.

Maintenance of highways has the dual purpose of conserving the public investment in roadway improvement and of insuring the safety, comfort and economy of vehicle operation.

By carefully maintaining earth and gravel roads their life is greatly increased.

Maintenance is the major activity of the majority of counties, particularly those in the states which have many miles of road and thinly populated areas, and where miles are long and dollars are short. It is, therefore, necessary to carry on maintenance operations in a progressive, business-like manner at all times.

The local resident pays only about one-fourth of the cost of a road and because he lives on and uses these local roads he gets at least three-fourths of the benefits.

Truly the small taxpayer should not complain of his bargain.

Yesterday a man told me of a local taxpayer who said he had been regularly paying road taxes for 10 years, and that he wanted the road improved to his ranch; when asked if road improvements costing what he had paid in taxes would satisfy him, he said it would.

A checkup on his tax account showed he had paid only $45 in 10 years.

This, I assume, is a typical case, and shows that most of us fail to realize how little our roads cost us as individuals.

As custodian of this investment in roads it is your duty to properly care for your trust.

You will receive more blame for poor roads than for good ones. Road-users are more interested in how well you take care of their investment than in listening to excuses as to why the roads are bad.

But what is the final answer? Just this: we pay for roads whether we have them or not. New farmers, new business and industry, are attracted to communities which have good roads, and they avoid those which have poor roads.

The situation is well summarized by a past president of the Road Builders' Association, C. M. Babcock, who recently said in addressing the County Commissioners' Association of Minnesota:

> "Undoubtedly in many counties road work is sufficiently advanced so that some curtailment of construction can be made without danger, but I want to caution you against going too far. We must remember that our road and bridge taxes, whether they are vehicle and gas taxes or direct levies, are just a part of our vehicle operating cost. They are a part of our transportation bill, and not a part of the cost of government in the ordinary sense that taxes are used. I want to caution you especially against any cut in maintenance expenditures unless you have made a careful check of your road conditions. Any curtailment of maintenance which will result in impairment of the roads already constructed, or which will increase the cost of transportation of farm products, would be very short-sighted economy. I also want to caution you against any haphazard slash of your construction program. Under present conditions of agriculture and business generally, it is imperative that reductions in tax levies should be made wherever possible, so that the burden on the property owner is lessened as much as possible. Bue your road and bridge budget should be carefully studied so that you do not pile up future road repair bills or increase in transportation costs greater than the savings in taxes.
>
> "With the steadily increasing traffic it is hardly safe to curtail maintenance unless this can be done by improved and more economical methods. Any curtailment of accomplishments in your maintenance work will be short-sighted economy. Failure to provide proper maintenance for your roads will in many cases result in a deterioration of these roads and necessitate much larger expenditures at some future time. It will also result in an increase in the cost of motor vehicle operation, and since the larger part of the traffic is local traffic, the bulk of this increase will be borne by the people of your own county."

A demand for tax reduction at this time is natural because of agricultural and business conditions. But to bury the transportation dollar in the mud and dust when road conditioning will save it is false economy.

It is poor judgment to reduce road budgets without carefully considering all the facts in the case. To save a few dollars now by neglecting our roads will cost someone many dollars to correct our mistakes.

COUNTRY ROAD
Practice in Scotland

By GEO. S. BARRY, F. S. I.
County Surveyor, Ayrshire

THE foundation of highway administration in Scotland rests upon the Roads and Bridges (Scotland) Act, 1878, and the Local Government (Scotland) Act, 1889. The former measure ended the turnpike system and brought into operation a body known as the Road Trustees; the latter measure abolished the Road Trustees and brought into existence the County Councils and District Committees. The coming into operation of the Local Government (Scotland) Act, 1929, saw the end of the District Committees and the County Councils become the sole authority for the landward area of the county. This measure also brought under the control of the County Councils the classified roads within the small burghs (burghs of 20,000 and under).

The highway system of Scotland is under the charge of 249 Local Authorities, of whom 31 are county, 24 burghal (large) and 194 burghal (small). This system embraces 25,329 miles of highway made up as follows: Class 1, 6,452; Class 2, 3,915; Unclassified, 14,962; total of all roads 25,329 miles, of which the length controlled by County Councils amounts to 22,901 miles.

Taking the year 1928-29 as fairly representative, the expenditure upon Scottish highways in respect of maintenance and minor improvements amounted to £6,018,606 and Ministry of Transport grants in the same year amounted to £2,030,424.

The administration of county highways is carried on by a Chief Surveyor in each county assisted by a number of Divisional Surveyors each responsible for a definite area. There are eight counties still carrying on under the arrangements hitherto in general operation, viz., by districts with a Surveyor responsible for each, but with no Chief or County Surveyor.

The central belt of Scotland is industrial in character and is the most heavily trafficked part. North and south of this belt the areas are mainly of a rural or agricultural character.

The Contract System.—The method of highway maintenance at one time in general use was the contract system. A county or district was divided into a number of sections of from 15 to 20 miles in each. Schedules made up by the Surveyor from his annual estimates and showing the requirements of each road, e. g., coating, patching and general maintenance, side dressing, quarrying and breaking of metal, etc., were issued. It was usual for the Surveyor to meet with intending officers at certain points and explain any matters, such as the particular quarries allocated to the various sections and so on. The author believes that he was the last Surveyor in Scotland to operate the contract system.

The coming of the war brought with it difficulties for the contract system and it eventually broke down and the direct labor or departmental labor system was introduced. It may, therefore, be said that highway maintenance throughout the whole of Scotland has, since the war, been carried on by means of departmental labor.

The Departmental Labor System.—This method varies to some extent. In some counties the arrangement is to have a lengthsman in charge of so many miles of highways and a number of flying squads for coating and spraying operations; in others the area is divided into sections of from 12 to 25 miles of highways with a foreman and from two to six roadsmen in charge of each. When coating operations are carried out the squad is formed by pooling two or more sectional squads. In two or three counties a modification of this method has been adopted, viz., by dividing up the county into areas each containing from 60 to 80 miles of highways with a general foreman and from 20 to 30 roadmen in charge. Apart from the above, many road authorities contract out their spraying work and in some cases special reconstruction work as well.

Another feature which has been adopted within recent years is a central depot for the housing and repair of plant and the keeping of spares, tools, etc. There are many well equipped road workshops in Scotland and they have been the means of not only enabling plant to be kept in better condition but of reducing the cost of repairs. Where, however, plant requires extensive repairs, the work is done by engineering firms in the usual way.

Quarries and the Production of Road Material.—Scotland is remarkably well provided with rocks suitable for use as road stone. Granite, basalt, quartz-porphyry, limestone, and whinstone in its various forms, are found.

There are, however, areas where good road stone cannot be got and road authorities have to import suitable material. This generally applies to areas where the geological formation is sandstone. For some years back slag has been used mainly in the iron and steel-working localities. Slag found in these areas is somewhat variable in quality and is not always well suited for the making of tarmacadam. This slag, however, makes excellent bottoming and in some cases fairly good chippings, but this applies to the cold blast and acid types and to steel slag.

During the past ten years many Local Authorities have adopted the central quarry idea and there are a number of very efficient plants now in operation. Parkthorn Quarry (Ayshire), Duntilland Quarry (Lanarkshire), Torphins Quarry (Mid-Lothian), and Tranent Quarry (East Lothian) are good examples.

Numerous small quarries are also worked and serve a useful purpose. The general practice is to have a squad provided with a portable compressor going the round of these quarries and boring and blasting down sufficient rubble for the season's requirements. This squad is followed by another provided with a portable stone breaker and engine. In this way the Local Authorities' requirements in road metal and chippings are to a large extent met. Sometimes a portable tarmacadam mixer is used, chiefly in outlying areas which are not conveniently situated in relation to central quarries. It is much better to have a small number of quarries of good material than a large number of quarries of indifferent material. It is more economical to transport good material some

distance than to rely upon indifferent material because it is near the work. A periodical review of the quarry question will probably show that a number of quarries might with advantage be closed down. When it is decided that a quarry be closed two alternative methods may be adopted. The road authority may partially fill up the quarry, remove the fences, and reduce the sides to easy slopes, afterwards covering the whole area with a depth of one foot of black soil; or they may get the owner or occupier to relieve them of all responsibility for the quarry by paying to him a capital sum equivalent to so many years surface damages.

Hand-broken metal is now practically a thing of the past and the itinerant stone breaker is seldom met with. The author still employs a number of hand-breakers and is of opinion that a good hand-broken metal is superior to the machine-broken kind for dry and waterbound road construction. Some years ago he found it necessary to carry on extensive strengthening of the more important unclassified roads and did so by coating with hand-broken metal made to 3-in. gauge. The use of this size of metal on weak roads proved a wise policy.

Surface Treatment.—The methods adopted apply generally to roads whose traffic does not exceed, say, 4,000 tons per day and the aim is to apply a material which will keep the surface sealed and intact for at least two years. This means the application of dressing every other year. If it becomes necessary for a road surface to be treated every year some other and more economical method ought to be adopted. The materials used in Scotland for surface dressing are: (a) tar, (b) a compound of tar and bitumen, (c) bitumen and (d) bitumen emulsion.

With regard to tar the types produced in Scotland are gas works (vertical retort and horizontal retort), coke oven and blast furnace. The greater proportion of tar is the vertical retort type which represents probably 62 per cent of the total output, which is round about 180,000 tons per annum. Coke oven and horizontal retort tar represent each about 10 per cent of the total.

The claims of tar have been given much prominence in recent years and Scottish Surveyors have not always been able to reconcile their practical experience with them. To put the matter briefly, Scottish "vertical" tar is not of the same quality as that produced across the border and the reason appears to be the difference in quality or type of the coal distilled or carbonized. It has therefore been found that if this tar is to be used with reasonably good results it must be reinforced with bitumen. An admixture of tar and bitumen in the proportion of 75 per cent of the former to 25 per cent of the latter has become more or less a standard mixture. While it may be said that 25 per cent of bitumen is practically the limit if a true chemical mixture is to be obtained it has been found in practice that a greater percentage of bitumen, e. g., 40 per cent, while producing a mechanical mixture instead of chemical mixture, has given excellent results upon roads carrying a fairly heavy volume of traffic. There are not now many road authorities who use tar alone for surfacing, but it is a sound policy to do so in the case of a waterbound or dry-bound surface which is being treated for the first time.

The price of road tar has shown amazing fluctuations over the past twelve years and they have been a source of annoyance to surveyors, especially when they are preparing estimates for work which is to extend over a period of years. For example, the price of road tar at present is practically double what it was a year ago. There does not seem to be any reason for so great a variation and tar producers would be well advised to devise a means for arriving at a figure which would have some stability.

The introduction, about ten years ago, of bitumen emulsion was undoubtedly a forward step in road maintenance. Prior to that it was notorious how much new coating went to waste durng the winter months because the sealing up of the surface could not then be done with hot applications. In its early days bitumen emulsion was far from perfect, and there were many who fought shy of the idea of putting "water" on to their roads. Nevertheless, the material has shown a steady improvement and its quality today stands very high.

The manufacture of the material is accomplished by means of a colloidal mill and the composition of a good bitumen emulsion may be taken as:

	Per cent
Bitumen	62
Emulsifier or stabilizer	2
Water	36

It is generally conceded that 65 per cent of bitumen is the maximum amount that can be emulsified with success.

The recently issued British Standard Specification for bitumen emulsion does not perhaps strike as high a standard as it ought to have done. Surveyors, generally, require a material which contains as high a percentage of bitumen as possible, yet there are emulsions on the market which probably contain as low as 45 per cent or 50 per cent of bitumen. The two chief qualities required of this material are the ability to hold fairly large sized chippings and to keep the road surface properly sealed for a reasonably long period. The application of this material is done by spreading with squeegees or spraying by means of pressure tanks. In the author's experience the former is preferable as it helps to take out slight irregularities and produce a more even surface. There is no objection to applying this material to a slightly damp surface and it is sometimes helpful to dampen a surface which is very dry before application. It is, however, a mistake to use the material during rain or when the road is very wet.

The application of chippings is done immediately after the emulsion is applied and the area treated should be closed to traffic for two or three hours to give the emulsion a chance to firm up and thereby grip the chippings. Some bitumen emulsions take longer than others to firm up, but a good quality material should carry traffic without any dislodging of chippings within a few hours of application. It is desirable, but not absolutely necessary, to roll the chippings. The emulsion should be applied at one gallon to three square yards of surface. A thinner application than this is not desirable, but much will depend upon the nature of the surface. Some brands of the material, while effectively sealing the surface, fail to hold all the chippings. The ideal emulsion is that which does both. While, generally speaking, ½-in. chippings are the largest that can be used with success, ¾-in. chippings may be used provided they are rolled and traffic kept off for at least 24 hours. Bitumen emulsion is supplied in woden barrels, iron drums, and road tanks, but the author's experience is that the wooden barrels are the best especially during the winter period when very severe frost is sometimes experienced. Under these conditions the containers should have some kind of protection, but it has been found that in the wooden barrel an emulsion is not affected to the same extent as in the case of iron drums.

The use of bitumen alone has been considerably extended in recent years especially on routes carrying a fairly heavy volume of traffic. This material has un-

doubtedly reached a very high standard during the past two years.

When a spraying grade of bitumen was first introduced it was made with a penetration of 200 or thereabouts. Experience has shown that a lower penetration, e. g., 120-150, is better suited for surfacing in this country.

It is hardly necessary to draw attention to the importance of using tar-bitumen compound or bitumen at or very near the correct temperature. It is sometimes difficult to get workmen to appreciate this point, and many of them seldom use the thermometer but rely on their judgment of the appearance of the material in the tank. General foremen should be carefully instructed to check the temperature of the material every time they visit a job.

There are many types of spraying and gritting apparatus in use and they are all designed with the view of accomplishing the work as rapidly as possible. This has been of great value in those parts of the country where there is considerable interruption of the work through frequent rainfall, e. g., the west coast of Scotland. In the early days of tar-spraying the hot material was spread or painted on by means of brushes and it was a very good method. With the gradual increase in the areas dealt with this method was too slow and led to the introduction of of mechanical means. The application of hot material is now accomplished in three ways (a) by gravity, where the material flows through a perforated pipe, (b) where it passes (under pressure) through a series of nozzles, and (c) where it passes from the tank on to revolving blades and by them is thrown on to the road surface in the form of a fine and even spray. The author has made use of all three forms and is convinced that the last mentioned is the most efficient. The application of chippings by hand is rapidly becoming a thing of the past. A suitable truck holding from three to four tons of chippings and capable of passing on to the newly treated surface an even layer of chippings is the most efficient method to adopt. An apparatus of this kind can lay 400 to 500 square yards at a single run. With a spare tank and a standby boiler continuous working is possible.

Coatings.—The types of coating in general use are as follows: (a) Water or drybound macadam, (b) tarmacadam, (c) tar or bitumen grouted macadam, (d) tarmacadam with a squeegee coat of filled bitumen, and (e) asphalt.

Tarmacadam has proved one of the most satisfactory forms of construction. This was demonstrated in the Scottish experimental roads laid down about 17 years ago. Over 20 years ago tarmacadam was made by hand-mixing, but the introduction of mechanical mixing plant has been the means of producing a better mixture and a higher output. Batch mixtures are preferable to the continuous mixing type. A thoroughly good tarmacadam is made up of graded 2¼-in. to ¾-in. broken metal with the application of British Standard Road Tar No. 3. The tarmacadam is spread at 9 sq. yds. to the ton and consolidated by roller to a thickness of 3¼-in. or thereabouts. The surface is then spread with ½-in. or ¾-in. dry chippings and rolled. A new coat of tarmacadam remains "green" for several days and failures of this form of construction have generally been due to allowing traffic to use it too soon. It is therefore a good policy to keep a new coat closed to traffic for at least a week. After the new coating has been in use for a month or six weeks the surface should be carefully swept and then sealed with tar-bitumen compound, bitumen, or bitumen emulsion, and thereafter covered with ½-in. to ¾-in. chippings well rolled in. As already mentioned, this form of construction has proved eminently satisfactory and with biennial spraying lasts for eight to ten years on roads carrying up to 4,000 tons of traffic per day. A variation of this method was tried some years ago and consisted of laying a coat of mixed 2¼-in. and 1½-in. tarred metal and superimposing a light coat of ¾-in. or ½-in. tarred chippings. It was rarely a success, for it was found that after two or three years the coat of tarred chippings peeled off in places due to imperfect adhesion with the sub-coat.

The cost of tarmacadam with sealed surface as above described ranges from 3s. to 3s. 6d. (72 cts. to 84 cts.) per square yard.

Grouting.—About twenty years ago pitch grouted macadam was in use in many parts of Scotland and on the whole the results were remarkably good. Yet this form of construction, for some reason, went out of use and during the past twelve years has not been used or only used in isolated cases. For several years grouting has been done with Tar No. 2 or with a compound of tar and bitumen. The metal is spread over the old road surface at 9 sq. yds. to the ton and rolled until there is very little movement of the stones. Chippings of ¾-in. size are brushed into the interstices and rolling continued until the coat is fairly rigid. The Tar No. 2, or compound, heated to 250° F., is poured over the surface by means of cans with flat nozzles. The application is best done in strips first in one direction and then in the opposite direction. This action gives the hot material a better chance to penetrate into the coat. It is important that the metal is dry and that the work is not done during damp weather. The tar, or compound, is applied at from 1 to 1½ gallons per square yard. Thereafter the surface is spread with more chippings which are brushed into the interstices and then rolled. The surface may now be left for a few weeks after which the sealing is done. This consists of brushing off all loose chippings and applying the heated tar, or compound, at or about half a gallon per square yard and spreading ½-in. or ¾-in. chippings, well rolled. In area remote from central quarries the "penetration" or grout method is a very satisfactory type of construction and many surveyors speak well of it. The same system may be employed with bitumen emulsion (grouting grade) instead of the heated material.

The cost per square yard ranges from 2s. 9d. to 3s. 3d. (66 cts. to 78 cts.) and the method is suitable for roads carrying 2,000 to 3,000 tons per day.

Construction for Moderately Heavy Traffic.—A form of construction which stands up well on roads carrying from 4,000 to 5,000 tons of traffic per day is a coating of tarmacadam superimposed by a light coat of filled bitumen applied at a temperature of 350° F. by means of squeegees and with ½-in. or ¾-in. chippings well rolled in. The filled bitumen is applied at 60 to 80 sq. yds. to the ton and it is important that the chippings are applied immediately. The advantage of this form of construction is that it obviates periodical spraying. The author has laid a good deal of it and finds that it provides a perfect surface which requires no attention for at least six years. When it does require attention, patching of the bare parts with the same filled bitumen will keep the surface right for another two years. In cost it works out at from 4s. 6d. to 5s. ($1.08 to $1.20) per sq. yd. Three important points to keep in mind are (a) the correct temperature, (b) keeping the material thoroughly agitated during heating, and (c) applying the material at an adequate thickness. With regard to the last point failure has frequently resulted through apply-

ing the filled bitumen too sparingly, say, at over 100 sq. yds. per ton.

Asphalt for Heavy Traffic.—The use of asphalt upon county roads in Scotland began about twelve years ago. In certain cities rock asphalt and mastic asphalt have been used for many years, but so far as the author knows they have not yet been tried upon county roads. Within the industrial belt of Scotland where, on many roads, the traffic reaches a very high intensity road authorities were faced with a serious problem shortly after the close of the war. The methods hitherto in use were proving quite inadequate to withstand the rapidly increasing demands of traffic and they were therefore forced into adopting a material which would end their difficulties. Asphalt was the material adopted and it has proved an eminently satisfactory one.

Both single coat and two-coat work has been done in the past, but the practice is now practically confined to two-coat work. This consists of a base or binder coat of bituminous macadam 2½ in. thick laid upon the old road. This is superimposed by a coat of asphalt 1¼ in. in thickness prepared in accordance with the British Standard Specification No. 342, 1928. The roughening of the surface is accomplished by rolling in ½-in. or ¾-in. chippings, precoated, during the consolidation of the wearing surface. Provided that the foundation of the road is perfectly stable the asphalt should give a life of twelve to fifteen years under heavy traffic conditions such as 8,000 tons a day. In cost the material works out at from 6s. to 12s. ($1.44 to $2.88) a sq. yd.

Footpaths.—The great need has been for a form of construction which is cheap and reasonably good. In a paper submitted by Messrs. Torrance and Gilmour at the last Scottish District Meeting a type of path which is adopted in Ayrshire was described. The method is very simple and consists of excavating and leveling the roadside waste and laying on top a 4-in. thickness of engine ashes. This is consolidated by means of a hand roller and thereafter sprayed with bitumen emulsion, preferably applied by means of a small pressure outfit. On top is spread a light coating of ⅜-in. limestone chippings, rolled. The cost is about 1s. 2d. (28 cts.) a sq. yd. and the result is quite satisfactory. A turf curbing laid alongside improves the appearance and costs very little.

Where foot traffic is considerable, as, for example, in large villages, a better but more expensive form of construction may be adopted. A coat of 2¼-in. dry metal is spread over the excavated side and after rolling to a uniform surface it is covered with a 2-in. thickness of 1½-in. tarred metal which is rolled and spread with ½-in. chippings and again rolled.

After this coat has been down for a few weeks the surface is sprayed with bitumen emulsion and covered with ⅜-in. limestone chippings, rolled. The cost is about 2s. 6d. (60 cts.) per sq. yd. It is usual to lay curbing alongside.

The high cost of putting in a dressed or nidged whinstone or granite curb led to the adoption of concrete curbing. For main roads a 6 in. x 12 in. size is best and this is manufactured in accordance with the British Standard Specification. Section No. 4 is probably the one best suited for county roads. In manufacturing the curb steel moulds should be used in preference to wooden ones as they give a far better finish. For use in towns a type of footpath which is finding much favor is that made by laying concrete flags. These are usually from 2 ft. 6 in. x 2 ft. to 3 ft. 6 in. in size and 2½ in. thick and the best kind is that made under pressure. It is, of course, essential that the bed of the path be absolutely firm and even, otherwise the flags or slabs will not present a uniform surface. In cost they work out at from 7s. 6d. to 8s. ($1.80 to $1.92) per sq. yd. and the chief advantage is that they can be removed without much difficulty when it becomes necessary to repair cables or pipes laid under them.

Foundation Work.—During the past twelve years more attention than hitherto has been paid to road draining and bottoming and side strengthening. The money spent on such works has repaid itself many times over and the only excuse that can be offered as to the very meager amount of these works done in pre-war years is the lack of funds at the time.

In the construction of a new road all these points can be dealt with without much trouble, but the problem is somewhat different when old roads have to be put into a condition to withstand the impact of modern traffic. The nature of the subsoil has a profound bearing on the matter and it will be found that this subsoil varies a good deal over Scotland. There are a number of counties where the subsoil is mainly of gravel; others where it is of clay; and in some others where there are large areas of peat moss. Consequently the problem has varied a good deal and each surveyor has had to tackle it in a different manner from another.

Generally, where the road crust is reasonably good and has a fair thickness it is left intact and attention is confined to the haunches. These are taken out to a depth of from 15 to 18 ins. and from 2 to 3 ft. in width apart from the widened area, which requires to be excavated to a greater depth. The building up then takes the form of a layer of engine ashes usually 4 to 6 ins. in thickness with hand-set slag or whinstone bottoming on top. When this has been thoroughly consolidated, preferably by a 12-ton roller, the surface is coated with dry macadam and thereafter the whole area is coated with dry macadam or other improved material. In some roads the crust may have an upper layer of about 2 or 3 ins. of tar and chippings—the accumulation of several years of periodical spraying and chipping. If, in this, it is found that the binding material is "dead" the whole thickness should be scarified off and properly regulated before the coating is done.

As to drainage it may be observed that, like bottoming and side strengthening, it was up till a few years ago a much neglected work. Roadside ditches, and field drains laid in the side wastes, constitute the only two methods of getting rid of surface water from the road. It has not been customary, except in the case of new roads, to drain the whole area of the road bed. It is usually found that if there are ditches deep enough to intercept the surface and subsoil water from the adjoining land and keep it 2 or 3 ft. below the level of the road they will be sufficient to keep the bed of the road dry. Where there are no ditches but drains the same applies. Acknowledgment.—From *Roads and Road Construction*, a British highway publication.

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Hiding Power of Paint

A new board to be used in determining the hiding power of paint has been constructed by the U. S. Bureau of Standards, according to its July Technical News Bulletin. This consists of 18 white and 18 black, opaque, glass squares (4 in. square), laid together in checkerboard fashion. In order to get the top surface as level and uniform as possible, the glass squares were laid face down on a smooth level surface (a piece of plate glass), and the cement placed on the backs of the glass squares, thus building up from the back of the squares.

County Installs Twin Multi-Plate *Sectional Culvert*

Dawson-Buffalo Hart Road, Sangamon County, Illinois, Is Graded, Oiled, and Partially Relocated

By Roy E. Smith,
Springfield, Illinois

PART of the program of road improvement in Sangamon County, Illinois, to be finished up this spring was the partial relocation for better alignment, the grading, and oiling of the 5-mile stretch of road between Dawson and Buffalo Hart, just east of Springfield.

It was not only desirable to grade it so as to secure a 30-foot roadway from shoulder to shoulder and eliminate several turns, but also to replace several of the drainage structures under this section of road. Probably the most important of these was a small bridge about 2 miles south of Buffalo Hart.

Erecting One 40-Foot Line of 120-Inch Multi-Plate Pipe on Site of Old Bridge

As the bridge was not only old but was also too narrow to meet the requirements of the improved road, it was both advisable and necessary to replace it.

As at least 40 feet in length was needed and a capacity of not less than 150 square feet of waterway area, cost estimates were made on a reinforced concrete structure first.

About this time the county officials learned about a multi-plate metal pipe, a pipe made up of sections and made of plates heavier than ever before used in this type of construction. Similar in appearance to the usual corrugated pipe, except that it is made of heavy plates strengthened with larger corrugations, this new Armco pipe, put on the market only a short time before, appeared to offer a solution for the bridge problem. The decision of the Board of Supervisors and the County Superintendent of Highways was to use a twin installation of this new type of culvert-bridge which would not only meet the requirements of this job, but could be purchased and installed immediately. They also used standard corrugated pipe for the other drainage installations on this road.

Bridge on Road from Dawson to Buffalo Hart

Work was started about September 1, 1931. By November 1 when they stopped for the winter all of the drainage structures were in place and all but one mile of roadway was completed.

Replacing the Bridge.—In October the old bridge mentioned above was removed and the multi-plate pipe was erected in place by county workmen. The 120-inch diameter culvert was received on the job in segments, 8 making a circle.

Starting with the 3-gauge or bottom plates first, the 5-gauge side plates were next added, using only sufficient bolts in each seam, about 6, to hold the plate and finally the top plates were added to complete the circle.

Then all the remaining bolts were placed and tightened. Part of the pipe was erected with a small hand-operated crane, part without. All of the plates except the top ones were easily placed by four men.

Description of the Pipe.—The plates, formed and galvanized in the factory, were shipped, nested, and bolted together in the field to form a twin 120-inch diameter pipe. In bolting the plates together, the circumferential joints were broken by staggering the plates so that a continuous pipe was made without a complete circumferential seam. All the plates were 10 feet long, except that half of the plates at each end of the pipe were 5 feet long. Each plate was bolted to the adjacent plate. The plates were lapped 4½ inches in the longitudinal seams, and the bolts, one in the crest and valley of each corrugation, were staggered 2 inches apart.

All the work was done by county forces with county equipment under the supervision of Henry Jones, foreman on the job.

Equipment at Work on Fill and Road Relocation

Typical Cross Section, 30-Foot Grade, Oil Surface, Good Drainage

The equipment used on this stretch of road included 2 large crawler type tractors, 8 self-loading Maneys and 1 large blade grader.

Truman L. Flatt is County Superintendent of Highways; J. A. Todson, Engineer; Attorney Walter E. Lindgren, Chairman, and Dr. A. E. Dickerson and O. T. Myers, members of the Road and Bridge Committee of Sangamon County.

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Port of New York Authority Used Traffic Census as Basis for Conclusions in Feasibility Report on Proposed Bridge Across Raritan Bay

In compliance with the instructions and authorization of the state legislature the Port of New York Authority undertook and completed field investigations and studies which enabled it to report on the feasibility of constructing a vehicular bridge from Staten Island, New York, across the Raritan Bay to a point in the northern part of Monmouth County, New Jersey. The study was made both from an engineering and economic point of view.

Traffic Survey.—The counts covered Sundays and holidays, as well as normal week-days, and were well distributed throughout the year, including February (State Highway Department), May, June, July, August and September.

Origin and destination of the millions of vehicles moving between New York and northern New Jersey on one hand and points south of Perth Amboy and southeast of New Brunswick on the other, were determined by actual interview of thousands of motorists. This was done by a squad of 50 carefully trained inspectors of the Port Authority, 30 of whom were residents of the Amboys and vicinity appointed specifically for this clocking. The interviewing was done on eight different dates, including Sundays and week-days in May and July. These clockings, supplemented by additional observations of state licenses, made without stopping motorists, were used to divide the total traffic into zones of origin and destination.

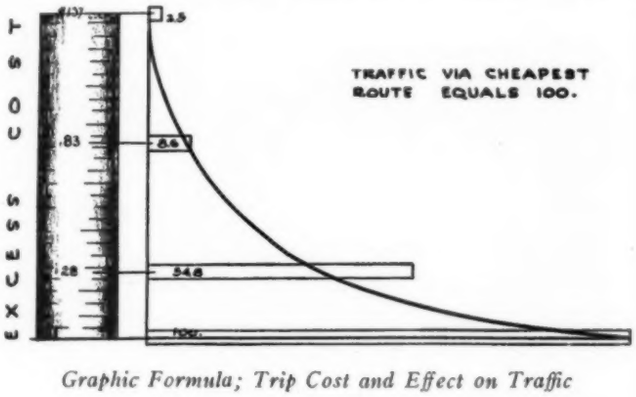
After ascertaining origin and destination, as well as total volume, additional field surveys were made of the travel time from each zone via various routes, including the proposed Raritan Bay Bridge route. This travel time, corrected for observed delays due to congestion during peak hours and waiting time at ferries, was established for each route. The actual mileage, or wheelage, as it is called, was recorded for motor vehicle operation over each of the routes.

Toll rates were also gathered for each route.

Analysis.—The facts obtained in the various field surveys and clockings were all carefully tabulated and computed. The total traffic moving between northern New Jersey and New York, on the one hand, and points in south Jersey on the other, was first estimated from the actual counts made in the field on selected dates. The fluctuation of traffic at the Victory Bridge from season to season and as between week-days and Sundays, resembles the observed variation in traffic over the Arthur Kill bridges operated by the Port Authority. Therefore, the silhouette of the recorded daily traffic on the Arthur Kill bridges was plotted and found useful in calculating the estimated yearly traffic at the Victory Bridge from the selected daily counts.

To the Victory Bridge traffic was added the detour traffic through New Brunswick via Route 25 and S-23 and similar routes, to get a grand total through both the Amboy and New Brunswick gateways.

The total traffic was then split on the basis of the field counts of origin and destination into appropriate zones, distinguishing the traffic local to the Victory Bridge from the through traffic, and separating through traffic as between Long Island, Manhattan, Staten Island, and counties in New Jersey. The next step was to estimate the amount of through traffic which might fairly be estimated as divertible to the proposed Raritan Bay Bridge between Seguine Point, Staten Island, and



Graphic Formula; Trip Cost and Effect on Traffic

Union Beach, New Jersey. This problem was approached from the common sense viewpoint of establishing and evaluating the importance to the motorist of such factors as travel time, wheelage cost, and toll rates in his choice of competitive routes. The mileage, time, and toll factors established by field observation were all evaluated in dollars and cents, using commonly accepted wheelage and time costs. When these were evaluated for each present route between key points in New York and northern New Jersey on the one hand, and southeastern Jersey on the other, *it was found that not only the bulk of the traffic follows the cheapest route, as might be expected, but also that the relation between cheapness of route and percentage of distribution of traffic was sufficiently exact to formulate a curve to express this relationship.* This relationship is shown graphically in the accompanying chart.

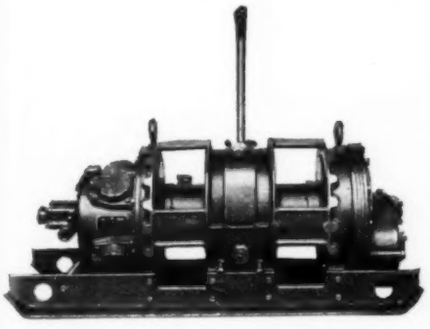
This observed tendency of traffic to follow the cheapest route, when all factors including time, wheelage, cost, and tolls are considered, was used as a formula for estimating the amount of traffic which might fairly be assumed to follow a new route having a given mileage, time, and toll. Again using the field observations of these factors, plus an estimate for the crossing of Raritan Bay, the relative cheapness of the route via the proposed new bridge from Seguine Point to Union Beach was computed for all key points.

New Equipment and Materials

New I-R Double-Drum "Utility" Air Hoists

Ingersoll-Rand Co., 11 Broadway, New York, has developed four sizes of double-drum "utility" air hoists that are said to offer many advanced and distinctive features. The application of these hoists is in sand and gravel pits, slushing and scraper loading in mines and quarries, etc., wherever portable double-drum air hoists are required.

An outstanding feature of the hoists is the single-lever control of the clutches and throttle valve, giving ease of operation and safety. The control lever located at the center and rear of the hoist operates



Front View of Size "HX" Utility Hoist

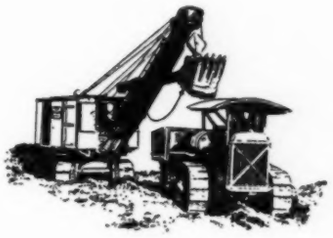
on the "joy-stick" principle. Swinging the lever sideways engages the clutch for either of the two drums and pushing it forward admits air to the motor. The speed of the motor is controlled by the forward position of the lever. Variations in drum speeds are regulated by the lever and without the need of slipping the clutch. Furthermore, the motor need run only when the hoist is actually pulling, thus reducing air consumption. The lever automatically returns to neutral if released —a safety device.

Compact cylindrical cast-steel housing construction fully encloses and protects the drums, clutches and brakes and assures proper alignment of all the moving parts. An internal expanding clutch is provided for each drum, operated by the single lever. Only one clutch can be engaged at one time. The main gears are of the helical type, reducing tooth pressures and insuring quiet operation.

The air motor is of the radial-four cylinder type similar to that used in single-drum "utility" hoists—a design proved dependable and efficient for hoist service.

The entire hoist is mounted on steel skids, giving a strong and convenient arrangement for spragging or mounting and also helpful in moving a hoist by its own power.

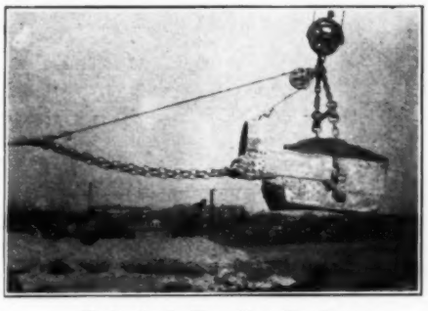
The four sizes are known as the HX, HXC, KX and KXB. The HX has a rated capacity of 1500 lbs. pull at 175 ft. per minute, while the HXC and KX are rated at 2000 lbs. pull at speeds of 130 to 215 ft. per minute respectively at 80 lbs.



air pressure. The KXB was designed especially for use with low air pressures. It has rated capacity of 2000 lbs. at 140 ft. per minute at 60 lbs. air pressure.

New Dragline Bucket

The new Red Arch dragline bucket (Type X) has recently been announced by Bucyrus-Erie Co., South Milwaukee, Wis. It is a general utility bucket for the average run of dragline work and is built in sizes from ½ to 8-cu. yd., full measure. Special attention has been given to a design and selection of materials which will give maximum strength and wear with elimination of dead-weight. Operation in the field is stated to have shown the new Red Arch fulfills the manufacturer's claim for ready digging, quick filling, easy carrying, and free dumping. Features include the red arch, a one-piece, annealed steel casting providing great strength without



Red Arch Dragline Bucket

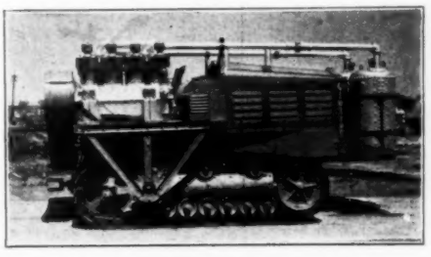
excess weight; a strong, smooth, manganese steel lip with low-cost renewable manganese steel teeth; tooth bases cast into lip; teeth secured with simple wedges; inexpensive, easily replaced runners and wearing plates protecting bottom of bucket. There are many other special features.

New Compressor-Tractor Unit

Cleveland Tractor Co., Cleveland, O., working with the Davey Compressor Co., Kent, O., has developed an improved method of mounting a heavy-duty air compressor on its heaviest tractor—Model 80 —without in any way interfering with the drawbar work of the tractor. This development is stated to have resulted in an efficient and sturdy machine which combines two pieces of equipment that heretofore were sold separately. The tractor is standard, except for the specially designed mounting bracket and platform and the power takeoff.

Two 4-cylinder Davey air-cooled compressors, with a combined displacement of 640 cu. ft. p. m., are mounted tandem, and are connected with drive sheaves by independent sets of V-type belts. A 4-in. diameter heat-treated chrome nickel steel shaft 94½ in. long extends through the tractor, fitting into the track frame at either side. This serves to carry directly the dead weight of the compressors, and to relieve the tractor transmission case of strain caused by the superimposed load.

Compressors are largely of aluminum, and weigh but 725 lb. each. Vibration is practically eliminated by this type of construction and by the fact that compressor



New Compressor-Tractor Unit

crankshafts are precisely counterweighted and large bearing areas are provided at both ends of the crankshaft and between cylinders. By putting the weight of the compressor over the tracks and near the seat, the equilibrium of the machine is so well established that it will operate successfully at an angle of 40 deg. in any direction.

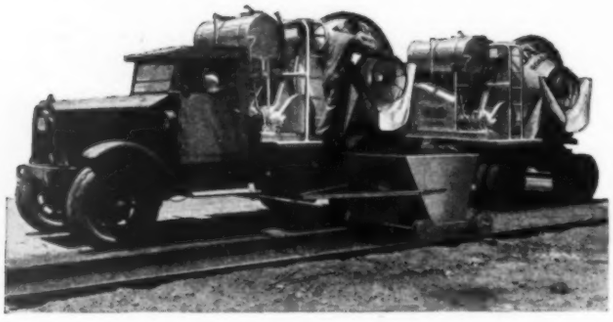
Such additional parts as supporting brackets, air receivers, sheaves, etc., are located so as to lower the center of gravity, and thereby also help to reduce slippage by increasing traction where the ground surface is hard and smooth.

Under a test speed of 750 r. p. m. the compressors are stated to have shown an efficiency of 72.5 per cent at 100-lb. pressure; 76 per cent at 90 lb.; and 80 per cent at 80 lb. Translated into air delivery at outlet temperature these efficiencies are 460 cu. ft., 486 cu. ft., and 512 cu. ft., respectively.

New Truck Mixer

The Jaeger Machine Co., Columbus, O., has developed a truck mixer unit specially adapted for use in highway widening and curb and gutter work, as well as sewers, sidewalks, culvert and general commercial concrete delivery. In addition, the side discharge feature of this unit makes possible the new Jaeger method of building roads and streets.

Side discharge mounting increases the distance from the truck center line at which concrete can readily be discharged and further permits the use of the truck mixer and trailer mixer longitudinally of the work being poured, thus eliminating the delay of backing and turning the truck.



Jaeger Road Builder Truck Mixer

The new dual discharge (discharged from either side of drum) will discharge either 2½ or 5 cu. yd. batch in less than one minute, and when used in connection with Jaeger concrete spreaders, the daily yardage on road work is stated to be limited only by the number of trucks operated and the amount of roadbed prepared to receive the concrete.

For road widening work the small, inexpensive distributing box is fastened to a quickly removable pipe on the truck chassis. This box, drawn along with the mixer, spreads the concrete as rapidly as the batch is discharged, greatly increasing the speed of the widening operation and reducing spreading costs.

These units are also adapted for general commercial concrete delivery, since, in many instances, ability to discharge on the side increases the range of delivery by 4 to 5 ft. without need of elevating mixer drum.

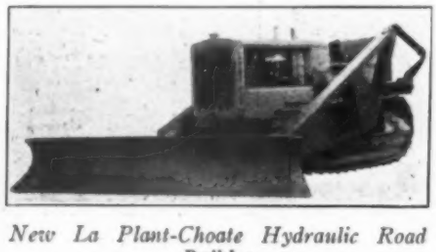
Jaeger road builder truck mixers with dual side discharge are built in 2½ and 5 yd. capacities. Jaeger truck mixers are built for rigid control with water measuring devices accurate within one-half of one per cent and batch meter which can be locked to comply with state highway regulations.

New Hydraulic Roadbuilder

The Laplant-Choate Mfg. Co., Inc., Cedar Rapids, Ia., has brought out a new hydraulic roadbuilder for use on the "Caterpillar" Thirty-five tractor.

Certain outstanding features are claimed to make this new roadbuilder a particularly useful tool for use in building mountain roads, trails, fire-breaks or on any other job where it is necessary to cut into a side bank.

The blade is 9 ft. 4 in. long and is completely oscillating with adjustments provided so that either end can be locked into any position desired. The blade will oscillate up or down at either end 16 ins. A sharp all steel removable cutting bit is provided at each end of the blade. The blade can be set at an angle for backfilling or sidehill cutting work or it can be set straight across for use in bulldozing work.



New La Plant-Choate Hydraulic Road Builder

Other features of this 35 roadbuilder are the extreme high 31 in. lift of the blade above ground level; the newly designed main frame and jack which enables the blade to be forced into the ground 20 ins.; a double acting jack which forces the blade into the ground, or raises it out, in the hardest going; a design which leaves the tractor drawbar entirely in the clear, enabling the tractor to be used for hauling wagons or any other equipment without removing any part of the roadbuilder; a reversible and removable cutting edge and many other interesting features.

Bigger Tractractor Announced by International Harvester

Another addition to its crawler tractor line has just been announced by International Harvester Co., Chicago, Ill. It is the new Model T-40 six-cylinder Trac-TracTor, a bigger and more powerful unit than the Model T-20 TracTracTor which was placed on the market a few months ago. The T-40 develops a maximum drawbar horsepower of 40 and a maximum engine horsepower of 52 as compared to the maximum drawbar horsepower of 23 and a maximum engine horsepower of 31 for the T-20.

Accessibility of working parts of the new T-40 TracTracTor is worthy of particular mention. Steering clutches, transmission, and brakes may be easily inspected, adjusted, or removed through top and rear cover plates, making for surprisingly low maintenance cost. Special dust seals guard every shaft and bearing. Like the Model T-20, the new T-40 is compactly built. The light weight per unit of track area and ample power available are claimed to fit it for heavy hauling and pushing work over fine sand and soft, mucky soil; over rough, rocky places; and up and down steep slopes. The tractor is easy to operate, for all controls are within ready reach of the driver and there is an unobstructed view from the tractor seat.

The large, positive-acting plate steering clutches, a new crawler tractor feature, are in the rear compartment of the main frame. The steering brakes are immediately to the rear of the clutches. Efficiency of operation is enhanced by the use of 44 ball bearings. The 6-cylinder engine is of valve-in-head design and has removable cylinders of 3⅝-in. bore and 4½-in. stroke. The cooling system, consisting of the radiator, impeller pump, fan, thermostat, and water jacket, is designed to provide a uniform temperature for the efficient utilization of the fuel and to assist in proper lubrication protection. The radiator is protected by a heavy grid and guards. There is a saddle-type-mounted heavy transverse spring which carries the front weight of the tractor. Independent angle braces keep the tracks in true alignment and also permit free oscillation of each track to conform to ground conditions. There are five lower track rollers and two upper rollers. An oil bath surrounds each track roller and the front idler shaft.

The overall length of the new T-40 is 141 ins.; overall width, 61¾ ins.; height over air cleaner top, 73½ ins.; drawbar height (high), 17 11/16 ins.; drawbar height (low), 10 15/16 ins.; tread width, 47¾ ins.; track shoe width, 16 ins.; and length of ground contact, 70½ ins. The fuel tank capacity is 45 gals. and the approximate weight, 10,600 lbs. The tractor operates at five forward speeds, respectively, 1¾, 2¼, 2¾, 3¼, and 4 miles an hour, and at 2¼ miles reverse. These varied speeds enable a man always to operate at the best speed for most efficient work.

McCormick-Deering Model T-40 Trac TracTor

New Type High Traction Tire

Following three years of experimental work, announcement has just been made of a new type of high traction tire known as the "Zero Pressure" and perfected to meet the needs of tractor service. This announcement follows grant of a patent covering this radical new development, issued to The B. F. Goodrich Company, Akron, O., manufacturers. Outstandingly successful in road work during the long experimental period, the manufacturers believe that the "Zero Pressure" can be adapted to all kinds of work that a tractor is called upon to perform.

It is called "Zero Pressure" because it has cushioning qualities equal or better than a pneumatic, yet has no air under pressure within the tire. The tire is designed to provide a snow-shoe effect in loose or soft soil, or sand, having a tread which deflects readily under load and provides unusual tractive qualities. As the tire is not under air pressure, no penetrating obstacle can damage it or cause delay.

Bouncing is eliminated, the tire rides easily, will not damage pavements, requires no inflation, and allows the equipment to operate at a greater efficiency. The tire has already been widely accepted on road construction machinery and in some types of agricultural work.

The tread is designed to give positive, sure-footed traction under all conditions with a minimum amount of tread wear. The development of the "Zero Pressure" tire was started at the request of some of the most important tractor manufacturers who had asked a prominent wheel maker to evolve a wheel and tire that would perform satisfactorily in the sand as experienced in citrus grove cultivation.

The Goodrich Company was requested to build a tire that required no servicing and which would perform better than a pneumatic.

There were three primary requirements for the tire engineers to keep in mind as they started experimental work:

(1) Positive traction.

(2) Ability of the tire to ride on top and not dig in.

(3) The tire must be troubleproof.

The results of this experimental work brought out a tire consisting of a rubber arch built on a sloted steel base for application to solid tire wheels. The piers of the arch are of sufficient size and rigidity to provide ample carrying capacity. The all-rubber arch is very flexile, and gives full tread contact.

Because it does not have any air under pressure, this tire in service assumes a concave tread profile under load. In sand or soft soil, this results in packing the material under the center of the tire, producing a track for the tire to ride on and causing it to ride on top of the loose material rather than dig itself in. It does not assume the conventional round tread face as does a pneumatic.

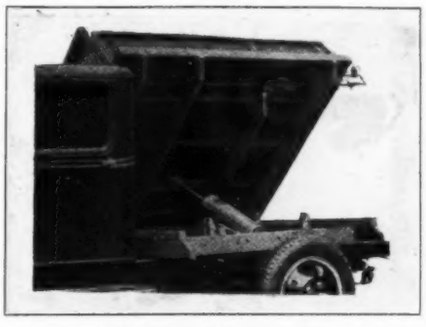
The "Zero Pressure" tire is readily flexible but not resilient—also because there is no air under pressure inside this tire. The "Zero Pressure" being flexible without air pressure, does not bounce when it encounters an obstruction, but rolls evenly over all obstacles thus increasing traction and eliminating wheel chatter. Another major advantage of the new type tire is the opportunity it affoirds for providing lighter wheel installations than have formerly been used on tractors.

At start of its development the new tire was primarily intended for use in Florida. Its advantages there were so marked, however, that it gradually got into other tractive uses, principally in road building equipment. Its successful performance under many kinds of severe conditions during its testing period has indicated to the manufacturer that it is an outstanding tractor tire for nearly every kind of service.

Among present users are the States of Ohio, Pennsylvania, North Carolina, Missouri, and Washington, the cities of Cincinnati, O., and Battle Creek, Mich.—The Illinois Canning Company, Wilson and Company, Dr. Phillips orchards, Carpenter Farms, the Southern Compress Company, and many others.

New Side Dump Body

A new hydraulic side dump hoist and body for trucks having a rated capacity of 1½ tons has been placed on the market by the St. Paul Hydraulic Hoist Co., St. Paul, Minn. The body was developed primarily for road maintenance and is used by highway departments for repairing shoulders, filling ruts and leaving stock



St. Paul Model 36 UB Hydraulic Side Dump Hoist and Body

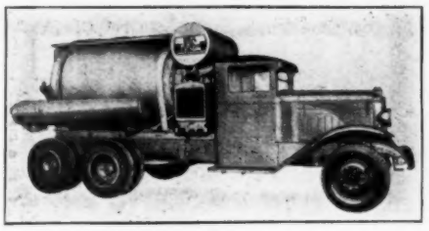
piles. The sides can be removed and the tailgate lowered flush, making a platform convienent for carrying snow fence, equipment, etc. The body dumps to one side only. Has a capacity of 1½ to 2 cu. yds. and a high dumping angle. The controls are in the cab and the body can be stopped at any dumping angle.

New Truck Mixer

A new Rex moto-mixer has been added to the line of the Chain Belt Co., Milwaukee, Wis. As a truck mixer, this unit handles 5 cu. yds. of mixed concrete, as an agitator, 7 cu. yds. The Chain Belt Co., introduces this model for the big ready-mix plant, especially the plant operating on big contracts. The 7-yd. agitator is stated to be the largest pay load that can be put on wheels.

This new Rex unit carries all the features which have been standard in Rex moto-mixers for the past two years. Drum has three-point suspension with the forward end riding on a single SKF ball bearing, the rear end on two Timken equipped rollers. Mounting is such that the drum rides between the sills for a low center of gravity. The conical front section of the drum is combined with extremely large mixing impellers to provide a satisfactory mixing action. Discharge can be controlled through a hand wheel and worm and gear reducing unit.

This unit, like all other Rex moto-mixers carries the one-man spout which Rex has featured for some time. The end of the spout nearest the discharge is mounted on a double hinge. When the truck is traveling, the spout rides in a cradle be-



New Rex Moto-Mixer

side the drum, replacing one fender. At the job, the operator merely walks it into position around the hinged end.

This new Rex moto-mixer can also be equipped with the Rex-Heil jackass hoist, which the manufacturers claim practically doubles effective spouting area and permits discharging into storage hoppers without ramps.

The water system on the mixer unit is based upon a calibrated overflow pipe. The pipe is set to the desired quantity. All water above that amount overflows, preventing all danger of accidental sweetening of the batch. The water tank carries a second compartment for washout water.

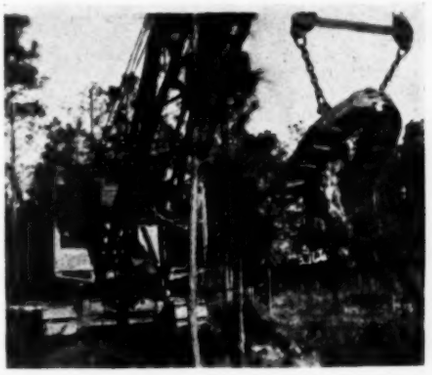
Both mixer and agitator units are driven by independent motors equipped with electric starters taking their "juice" from the truck battery. All controls are located at the rear of the machine to facilitate discharging. But starting the engine and drum can be handled from the driver's cab.

New Stump Pullers

The P. & H. stump puller, recently patented by Harnischfeger Corporation, 4400 W. National Ave., Milwaukee, Wis. operates similar to a huge nutcracker. It is operated in connection with a crane or dragline.

The puller is reeved up and operated much like a dragline bucket. The drag cable is attached to the triangularly reeved cable at the front end of the puller. The hoist line is fastened to the spreader bar. When the drag cable is released, the puller arms open automatically. In this position the stump puller is lowered around the stump and rests on the ground.

The operation of pulling the stump begins by hauling in the drag cable which pulls the arms together until their knife-like edges are imbedded in the stump. With a continued pull on the drag cable and with the hoist cable held taut, the operation proceeds until the stump is out



P. & H. Stump Puller

of the ground. It is then raised to the proper height, swung to one side, and in dropping much of the sod and dirt is knocked off.

Made of heavy alloy steel throughout, each part designed with a liberal safety factor, the P. & H. Stump Puller has stood field tests with a maximum pull on both the drag and hoist lines of 25,000 lbs. This power will uproot the largest and heaviest stump. Like all other attachments commonly used on P. & H. full revolving excavators, the stump pulling device can be quickly installed.

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"Caterpillar" Announces Second Auto Patrol

A second auto patrol has been added to the line of the Caterpillar Tractor Co., Peoria, Ill. This addition makes it necessary to identify the two models. The present model, therefore, will hereafter be termed Auto Patrol No. 9. The new model Auto Patrol No. 7. "Caterpillar" auto patrol No. 7 weighs 10,600 lbs. and offers all of the performance features of the No. 9 machine. It offers the principal features of power control—three-lever power control, one for raising or lowering left end of blade, one for right end of blade, one available for either scarifier or snow plow attachment. It possesses generous strength, using the same frame members as the No. 9. It has the same engine and transmission as the No. 9. It has weight adequate for most maintenance work. It has traction correctly proportioned to its weight—dual 38x7 in. lug-type road builder pneumatic tires in the rear. Front tires are 32 in. x 6 in. truck-type.

Auto Patrol No. 9 continues to offer certain features that are not included in the No. 7. Its approximately 14,000 lbs. of weight provide the greater blade pressure and greater traction that are desirable in the heavier duty work. The No. 9 has lug-type tires, both front and rear and all tubes are of the puncture-proof type. It has five power controls. The No. 9, too, has fenders and bumpers for added protection. A canopy top for added comfort and electric lights for added operating hours. Practically all of these items, standard on the No. 9, are available as extra equipment (excepting the five-lever power control) at additional cost on the No. 7.

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Tu-Way Trailers

Load from either end, pull from either end, steer on all eight wheels from either end, operate brakes from either end on all wheels, pneumatic tires with an overload safety factor of 15 to 20 per cent, and operation at motor truck speed are some of the features of the Tu-Way trailer manufactured for sale by the C. R. Jahn Co., 1140 First National Bank Bldg., Chicago, Ill.

The frame is scientifically designed to provide equal distribution of weight over all axles and wheels. The main frame members run the full length of the trailer and are so spaced that machinery when

Pneumatic Tired Tu-Way Trailer.

properly loaded rests directly over the large, wide-flange beams. The short span between axle centers entirely eliminates the possibility of sagging frames.

Both ends of these beams are tapered to permit mounting of axle turn-tables and plates on the lower flanges, thus utilizing the full vertical strength of the beam throughout the central portion. It is impossible to make comparisons between this and any other machinery trailer in axle construction, primarily because the axles of the La Crosse Tu-Way are mounted under the frame members with increased pivoting action, and further, because it is possible to steer or apply the brakes regardless of the tilted position these pivoting axles may be in at the time.

The steering is accomplished by heavy arms securely bolted to axle shaft housing and connected by means of a cross steering rod through universal joints which permits pivoting action without affecting positive steering. The steering axles at the opposite end from which the trailer is being pulled are co-ordinated by means of a longitudinal reach rod with sliding block connection in the center.

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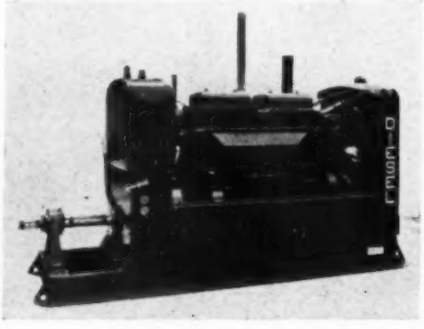
"Caterpillar" Stationary Diesel Ready

The diesel engine that has been developed by the Caterpillar Tractor Co., Peoria, Ill., after seven years of intensive research, is now to be made available to the stationary engine trade. It is now in production at the Peoria plant.

This engine has a 6⅛ in. bore, 9¼ in. stroke, and is governed at 700 R.P.M., developing better than 85 H.P. It has four cylinders, is 4-cycle, and uses the solid injection fuel system, and a pre-combustion chamber.

The fuel system of any diesel is generally the determining factor in its successful and economical operation. This



Caterpillar Diesel Power Unit Without Hood or Doors

factor has received the most serious consideration of "Caterpillar" engineers and the outstanding performance of the "Caterpillar" diesel is due to the simplicity, yet effectiveness, of its fuel system.

The solid injection method of handling fuel oil on this diesel is by means of individual pumps mounted on each cylinder. These are accurately calibrated and sealed at the factory, thereby preserving the intended settings under operating conditions.

The fuel injectors have a single orifice of .086 dia. (2.3 mm). A self cleaning pintle keeps this orifice from clogging and maintains its prescribed dimension.

The fuel in a "Caterpillar" diesel is first injected into a pre-combustion chamber, where it is ignited by heat generated by high compression.

This pre-combustion chamber prepares the fuel for the main combustion chamber in the form of a partly-burned rich, dry mixture, carrying no wet slugs, and therefore minimizing crankcase dilution and preserving lubrication on cylinder walls. Another quality is the fact that this pre-combustion chamber permits burning a wide range of fuels.

The engine is provided with a positive starting mechanism—a small 2-cylinder, 4-cycle gasoline engine, mounted on the side of the diesel itself. The engine is water cooled, being connected to the diesel cooling system. The exhaust gases of this starting engine warm the diesel intake for ease in starting. The starting energy is imparted to the diesel engine through a clutch and Bendix drive to the diesel flywheel.

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Combination Drum and Capstan Car-Puller Friction Clutch Type

A new combination type of drum and capstan car-puller for "spotting" a train of loaded railroad cars in either direction and at slow rope speed has been brought out by the Fridy Hoist & Machinery Co., Mountville, Pa. For handling long hauls of 900 feet and under steel cable is used on the drum, and for shorter hauls less than 300 feet the capstan is used to advantage with manilla rope.

The car-puller is furnished in the 7½, 10, 15 and 20 hp. motor drives for "spotting" a train of 500 tons and under, some of the special features embodied in its design and construction are as follows: A double V-shape friction clutch (asbestos lined); also the improved type of screw thrust assures of a positive grip and release of the drum by a slight movement of the operating lever which protects both the motor and mechanical construction of the car-puller against excessive strains and shocks when starting a heavy pull. The triple spur gear drive is of steel and enclosed in an iron housing. The main operating lever, motor control switch and foot brake are all located within easy reach of the operator. The complete car-puller is mounted on a steel I-beam sub-base.

Distributor News

Harman Now General Sales Manager for Keystone

The Keystone Driller Co., Beaver Falls, Pa., announces the appointment of G. L. Harman as general sales manager. Mr. Harman was, until recently, sales manager of the Industrial Brownhoist Corporation, Cleveland, having been connected in a simi-

G. L. Harman.

lar capacity with the Industrial Works of Bay City, Mich., from 1914 until this company was merged with the Brown Hoisting Machinery Co. Mr. Harman is a native of Bay City and graduated from the Engineering Department of the University of Michigan in 1906.

Simultaneous with the above appointment comes that of Lynn H. Ransom as chief engineer. Mr. Ransom is a native of Beaver Falls, Pa. In 1925 he received the degree of mechanical engineer from Cornell University. He has, since 1926, been connected with the engineering department of the Keystone Driller Co.

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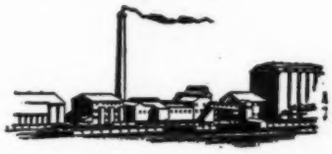
The Novo Engine Co. Announces a Change in Their Executive Head

On July 1st Clarence E. Bement resigned his post as vice president and general manager of the Novo Engine Co. to become chairman of the board. He will be succeeded by Eric P. Teel, formerly general superintendent of the company.

Mr. Bement, a pioneer in the manufac-

C. E. Bement



turing field, has long been considered a leader in the industry, having been actively in charge of the Novo Engine Co. for 25 years. Under his management the company has expanded steadily from the small manufacture of marine engines to its present position as one of the leading manufacturers of construction and industrial equipment. This equipment now includes single

E. P. Teel

and multiple cylinder gasoline engines, contractors', industrial mining and specialty hoists, contractors' pumps for dewatering, water supply and high pressure, engine driven generator sets and a line of air compressors for engine starting, etc. Mr. Bement fostered the idea of building specialty equipment for unusual jobs. The use of this type of equipment has expanded in recent years to form a considerable volume of the company's business, which is exemplified by their specialty hoists, pumps, combination hoists and air compressor outfits, combination compressor and generator outfits, etc.

The distribution organization has increased until it now includes several hundred distributor and jobber connections throughout the United States and foreign countries with branch offices in New York City and Chicago.

Mr. Teel has been connected with the company for 24 years, serving in the capacity of factory manager, as well as closely co-operating with Mr. Bement in the dispatch of the managerial work. Mr. Teel holds a position of high esteem in the industry, as recognized by the Pump Manufacturers Bureau, which organization has elected him president. Mr. Teel has been active along the line of design and development of new equipment.

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New Chicago Dealer for Allis-Chalmers

R. C. Larkin Co., 3900 South Wabash Ave., Chicago, has been appointed Allis-Chalmers dealer in the Chicago territory to succeed the G. E. Hillsman Co. Track-type and wheel-type tractors, including the Allis-Chalmers Model "L," "35" and "50," road graders, track-type wagons and other Allis-Chalmers products, are included in the franchise.

▼

Thompson Appointed General Manager Pioneer Gravel Equipment Co.

W. H. F. Thompson was recently appointed general manager of Pioneer Gravel Equipment Co. of Minneapolis, Minn., and president of Pioneer Equipment Co. (Canada), Ltd., of Brantford, Ont.

"Bill" or "Tommy," as his friends elect to call him, was born in Ireland. He was educated at Trinity College, Dublin University, and graduated in 1909 in Arts and Engineering. "Bill" came to the United States in 1910 and took a post-graduate course in engineering at the University of Minnesota, then some practical work in a student apprentice course with the Allis-Chalmers Co. of Milwaukee, Wis. Later he joined the sales organization of this company.

During 1918-19, U. S. naval aviation in Northern France claimed W. H. F.'s time. Returning to private life, from 1919 to 1924 he operated the Enterprise Machinery Co. of Minneapolis, which company consol-

W. H. F. Thompson

idated with the Imperial Machinery Co. in 1924. Came 1928 and a happy combination of circumstances made him one of the original incorporators of Pioneer Gravel Equipment Manufacturing Company, which is now his most absorbing business interest.

Mr. Thompson is a director in the Manufacturing Division of the American Road Builders' Association.

Worthington Official to Study Conditions Abroad

H. C. Ramsey, vice-president in charge of international business of Worthington Pump & Machinery Corporation, sailed for Europe on The Majestic on July 8. Mr. Ramsey will spend ten weeks in the British Isles and on the continent, where he will study conditions and visit Worthington's manufacturing and sales organizations in England, France, Germany, Spain, and other countries. He feels that much can be accomplished at this time by promoting closer cooperation between American organizations and their European associates, in anticipation of better coordination of activities in the future.

Winans Appointed Chief Engineer Federal Truck Co.

M. L. Pulcher, president of the Federal Motor Truck Co., Detroit, Mich., announces the appointment of Earl W. Winans as chief engineer, following the resignation of George B. Ingersoll, who formerly held this position. This promotion comes to Mr. Winans after an association with the company of nearly 16 years. For many years he served as special equipment engineer and also headed the Federal Body Division, in charge of engineering and design.

Mr. Winans' experience dates back to 1903, when following the receipt of his degree from the Engineering College of Purdue University he entered the engineering department of the Electric Vehicle Co., Hartford, Conn. After several years with this concern he accepted the position of chief engineer of the Regal Motor Car Co. and for five years occupied a similar post with the RCH Corporation prior to his affiliation with the Federal Motor Truck Co. in 1916. Mr. Winans is a member of the Society of Automotive Engineers and is an active member of several other engineering societies.

Dr. Jones New Director of Engineering at Carnegie

Dr. Webster N. Jones, general superintendent of the processing division, the B. F. Goodrich Co., Akron, O., has resigned effective Aug. 1 to become director of engineering of Carnegie Institute of Technology at Pittsburgh. Dr. Jones joined Goodrich in 1919 as research chemist and in 1925 he was placed in charge of the production chemical laboratories and the training of young technical men for the company. In 1927 he was appointed technical superintendent of the processing division and the following year became general superintendent of this major division.

Dr. Jones was born at Rich Hill, Mo., is a graduate of the University of Missouri from which he received both a bachelor's and a master's degree, and completed his graduate study at Harvard, earning a Ph. D. degree. During the war he conducted research on Lewisite and served as chemical expert on the War Trade Board. He holds a commission as Major in the Chemical Warfare Service Reserve Corps.

In engaging in educational work, Dr. Jones returns to a field in which he has spent ten years of his career, teaching at Purdue University in 1910, Harvard University, 1911, University of Maine, 1912, University of Missouri, 1913, and University of Montana, 1915-18. His interest in the careers of young men has been an outstanding characteristic and has contributed to his success in industry as well as in teaching.

He has been largely responsible for the development of a Goodrich training school, which prepares young men of talent for service in the organization, and has contributed many articles for scientific and technical journals.

To Observe Centennial of Birth of Nobel

The Institute of Makers of Explosives, 103 Park Ave., New York City, will observe in 1933 the centennial of the birth of Alfred Bernhard Nobel, "the father of high explosives."

In calling attention to the fact, the Institute points out that "Nobel's discovery of dynamite was one of the greatest boons to the advancement of civilization the world has known since the printing press was invented, and much of the industrial and economic, and even the social and political, progress of America may properly be attributed to the many contributions high explosives have made in the development of coal and metal mines, the construction of railroads, the building of highways, the improvement of harbors and in the construction of public and private works."

The Institute's announcement further states: "Nobel was a world renowned genius. He was born in Sweden, Oct. 21, 1833; educated in America and Russia; the founder of the high explosives industry; the first successfully to manufacture and use nitroglycerine as a blasting agent; and the discoverer of dynamite. The great need of improved explosives in his time is shown by the ease with which he established explosives factories in every prominent mining and industrial country of that time.

Nobel also invented blasting-gelatine, gelatine-dynamite, and a smokeless powder. He made a fortune in Russian oil and at his death left it for the founding of the Nobel Prize Fund, which has rewarded achievements in science and literature, and the promotion of world peace.

Foy Now Chicago District Sales Manager for Republic Steel

Norman W. Foy has been appointed Chicago District Sales Manager of Republic Steel Corporation, according to an announcement by N. J. Clarke, Vice President in Charge of Sales. Mr. Foy became associated with the old Republic Iron and Steel Co. as a salesman in 1919. He was subsequently manager of the company's Buffalo, Boston and Birmingham offices, being made assistant western manager of sales shortly after the formation of the present Republic Corporation. Mr. Foy will continue to make his headquarters at Republic's district sales offices in the McCormick Bldg., Chicago.

ATECO to Distribute Atlas Scrapers

The American Tractor Equipment Co., 5307 Horton St., Oakland, Calif., has closed a contract for the distribution of Atlas Rotary Wheel Scrapers on the Pacific Coast and in the Territory of Hawaii. Atlas Scrapers are manufactured in two models; the Model AC having the wheels outside the ends of the bowl; and the Model AF having the wheels behind and inside of the bowl.

Cletrac Now Distributed and Serviced by the Austin-Western Road Machinery Co.

The Austin-Western Road Machinery Co., domestic sales organization of The Austin Manufacturing Co. and The Western Wheeled Scraper Co., announce that they will handle the industrial sales and service of Cletrac crawler tractors in 24 states, broadly the territory covered by the Midwestern, Southern and Southeastern states.

This new arrangement of combining the sales of these prominent equipment manufacturers provides from one source a complete sales and service on a broad line of haulage, construction and road maintenance machines, including tractors, graders, elevating graders, fresnos, scrapers, planers, rollers, motor graders, motor sweepers, crushing and screening plants, crawler cranes and shovels, and a wide variety of accessory equipment.

The present Cletrac organization continues to handle nation-wide agricultural sales, and industrial sales and service in all territories other than that shown in the map herewith.

Worthington Consolidates Cincinnati with Buffalo Plant

Worthington Pump and Machinery Corporation, with executive offices at 2 Park Ave., New York, and general offices at their Harrison, N. J., Works, has announced the decision to transfer and consolidate the designing, engineering and manufacturing activities formerly carried on at their Cincinnati, O., Works with those of their Buffalo, N. Y., manufacturing plant.

During the past five years it has been the corporation's policy to foster the interchange of work between its various manufacturing establishments and to further this coordination by an interchange of key men. In order to fully conserve its position, skill and experience and to assure satisfactory service to its customers, necessary members of the Cincinnati Works organization are being transferred to Buffalo. Sufficient time is being provided for the move so that service to customers will be uninterrupted.